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Pimelia grossa Fabricius, 1792 - Italy, Sicily, mouth of the Belice river

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Cossyphus moniliferus Chevrolat, 1833. Italy, Sicily, Selinunte, under stones.

Probaticus anthrax (Seidlitz, 1896). Italy, Sicily, Ficuzza woods, under barks of trees.

The family of Tenebrionidae Latreille, 1802 (Coleoptera). Over 20,000 species belonging to the family Tenebrionidae are part of the fauna of our Planet. They are present in all continents except the areas permanently covered by ice. For Europe, the most abundant faunas are found in the Iberian peninsula and the Balkans, but also the fauna of Italy includes numerous species and subspecies, even endemic, mostly occurring in Sardinia and Sicily. Tenebrionidae are extremely variable in size and shape, adapted to almost all terrestrial environments. There are species large and massive, as many *Blaps* Fabricius, 1775 or *Pimelia* Fabricius, 1775, but also small and delicate, as *Ammogiton* Peyerimhoff, 1919, *Eutagenia* Reitter, 1886 and most Alleculini; there are omnivores and herbivores specialized, for example fungivores as *Bolithophagus* Illiger, 1798 and *Eledona* Latreille, 1796. Many species are related to forest (*Allardius* Ragusa, 1898, *Helops* Fabricius, 1775) or arid coastal environments (*Ammobius* Guerin-Méneville, 1844, *Xanthomus* Mulsant, 1854, ...) and can be found even in the deserts (*Prionotheca* Solier, 1836, *Mesostena* Eschscholtz, 1831, *Adesmia* Fischer de Waldheim, 1822, ...). Other Tenebrionidae live in the mountains at high altitudes, as some *Pedinus* Latreille, 1796 and *Heliopathes* Dejean, 1834, or take refuge in rotting trunks (*Iphthiminus* Spilman, 1973) or shallow caves (*Elenophorus* Dejean, 1821). Some species are myrmecophilous or anthropophilic, or still parasites of food, through which, taking advantage of humans businesses, spread throughout the world since very ancient times. Very interesting are the environmental adaptations of many species, especially those living in extreme environments, such as the hottest deserts of Africa, Australia or America. They overcome the risk of dehydration, not only limiting their activities to the twilight hours or at night, but also digging underground shelters (Pimeliini and Tentyriini), or progressing high on their legs alternating them rapidly on the hot ground (*Onymacris* Allard, 1885, *Zophosis* Latreille, 1802, ...), or by a small protective vescicle filled with air, located under the elythra (*Eleodes* Eschscholtz, 1829). A few Tenebrionidae are good fliers, as *Lagria* Fabricius, 1775, and all Alleculinae, but all the others are usually lacking, even in part, of functional wings, or show fused elytra, so their movements are very limited, or by passive transport. For this reason, Tenebrionidae are excellent biogeographical indicators. In Sicily, where there is about 50% of the taxa reported for Italy, I could see how the distribution of the Eastern Palaearctic, Afro-Mediterranean, European and Western Mediterranean species, exactly overlaps the tracks of human migrations which, over the centuries, often by successive waves, have affected the island where they fused in today's society that has strong trends of multicultural tolerance.

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Diversity of invasive plant species in Boluvampatti forest Range, Southern Western Ghats, India

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ABSTRACT The present study deals with the implication of invasive plant species on the diversity of Boluvampatti forest range in Southern Western Ghats of Tamil Nadu, India. A total number of 90 invasive alien species under 74 genera belonging to 37 families have been recorded based on field exploration and literature consultations. Among these, 53 species are being used by local inhabitants who reside in this forest range for medicinal purposes. Thirteen species have been introduced intentionally, while the remaining species established unintentionally through trade. The present study shows that a better planning is needed for early detection to control and reporting of infestations of spread of naturalized species to be scrutinized.

KEY WORDS Ecosystem; field survey; invasive plants; natural habitat; diversity.

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INTRODUCTION

Understanding the diversity of nature in various forms is a fundamental goal of ecological research (Lubchenco et al., 1991). Apart from the immense economic, ethical and aesthetical benefits, it is essential for the ecosystem function and stability (Ehrlich & Wilson, 1991; Holdgate, 1996; Tilman, 2000). It has also attracted world attention because of the growing awareness of its importance on the one hand and the anticipated massive depletion on the other (Singh, 2002). Biodiversity hotspots around the world contain high degree of endemism and are undergoing exceptional loss of habitats (Myers et al., 2000). Moreover, plant diversity around the world is facing various threats and is reducing very rapidly (Dogra et al., 2009).

The invasive species are widely distributed among all categories of living organisms as well as all kinds of ecosystems throughout the world. The invasion of alien plant species in the new regimes became a second highest threat to plant diversity after the habitat loss (Hobbs & Humphries, 1995). The spread of species beyond their natural habitats has always played a key role in the dynamics of biodiversity, but the present rate of species exchange is unprecedented and has become one of the most intensively studied fields in ecology. Invasive species may displace or otherwise adversely affect native plant species. These species often produce prolific seeds that may disperse widely and remain viable in the soil for long periods of time (Drake et al., 2003).

IUCN (International Union for Conservation of Nature and Natural Resources) defines Invasive Species as an alien species which becomes established in natural or semi-natural ecosystems or habitat, an agent of change and threatens native

biological diversity. A taxon can be considered successfully naturalized after overcoming geographical, environmental and reproduction barriers, while an invasive species requires, in addition, to overcome dispersal barrier within the new region (Richardson et al., 2000). They are noxious and cause negative impact in environment, ecosystems, habitats, native biodiversity, economics and even human health (Khanna, 2009).

Introduction of these species may occur accidentally or through their being imported for a limited purpose and subsequently escaping or deliberately on a large scale (Levine, 1989). Many of these species have allelopathic potential and possess high tolerance to different abiotic conditions (Huang et al., 2009). Many people introduce non-native species into new habitats for economic reasons (McNeely, 2001) and most cases of invasive species can be linked to the intended or unintended consequences of economic activities (Perrings et al., 2002). The differences between native and exotic plant species in their requirements and modes of resource acquisition and consumption may cause a change in soil structure, its profile, decomposition, nutrient content of soil, moisture availability (Walck et al., 1999; Vila & Weiner, 2004).

The biotic invaders tend to establish a new range in which they proliferate, spread and persist to the detriment of the environment (Mack et al., 2000). Invasive species has faster rates of growth and biomass production compared to native species, higher competitive ability, high reproductive efficiency including production of a large number of seeds, efficient dispersal, vegetative reproduction, rapid establishment and other traits that help them adapt to new habitats (Simberloff et al., 2005; Sharma et al., 2005). Despite the recent recognition of the impacts caused by invasive plants worldwide (Mooney & Hobbs, 2000), there are still many regions in the world where basic information on naturalized plant taxa and plant invasions is only anecdotal or completely lacking like Asia and neighbouring regions (Corlett, 1988; Enmoto, 1999; Meyer, 2000).

In India, comprehensive studies on invasive species and plant invasions are still missing except a few studies (Reddy, 2008; Khanna, 2009; Singh et al., 2010; Chandra Sekar, 2012; Chandra Sekar et al., 2012). A large number of exotics are naturalized, affecting the distribution of native flora and a few among them have conspicuously altered vegetation patterns of the country. There is an apparent need for a regional and national authentic database on invasive alien species for monitoring their spread and impact in various regions and for devising appropriate management strategies. In view of these facts, the present study was conducted to examin the implication of invasive plant species on the diversity of Boluvampatti forest range in Southern Western Ghats of Tamil Nadu.

MATERIAL AND METHODS

Study area

The study area (Boluvampatti forest) is situated about 30 km west of Coimbatore city and is a continuation of the Western Ghats lying North of Palghat Gap and to the South-east of the Nilgiris (Fig. 1). The area comes under the Boluvampatti range of Coimbatore forest division which includes the villages of Irrutupallam, Sadivayal, Semmedu and Siruvani. It lies between 10° 56′ and 10° 58′ N latitude and 76° 42′ and 76° 44′ E longitude. The elevation of this area is between 625 and 650 m asl (Subramanian, 1959). The rock formation is of Archaean age and consists of principally gneiss and its metamorphic variations. The gneiss foliated and is composed of quartz, feldspar and biotite (black mica) with an occasional admixture of garnet. The soil is reddish with irregular galleries filled with yellow clay running through and it has the property of hardening on to the air (Subramanian, 1966).

The climate is cool and pleasant for the major part of the year except during the months of March to May when it is hot and dry. The difference in elevation between the plains and the hilly areas makes appreciable variations in climatic conditions. The temperature ranges from 21ºC to 38ºC and the mean annual humidity is 51%. The vegetation of this area includes scrub jungle, moist deciduous and sub-tropical evergreen forests. These forests are subjected to extreme biotic influences and extensive areas near Sadivayal and Siruvani settling tank are planted with *Eucalyptus*, teak, bombax, etc. The natural regeneration of trees in these forests is very poor. Perhaps this may be due to excessive grazing and other biotic influences. There is a profound invasion of many non-native species on biodiversity of this area.

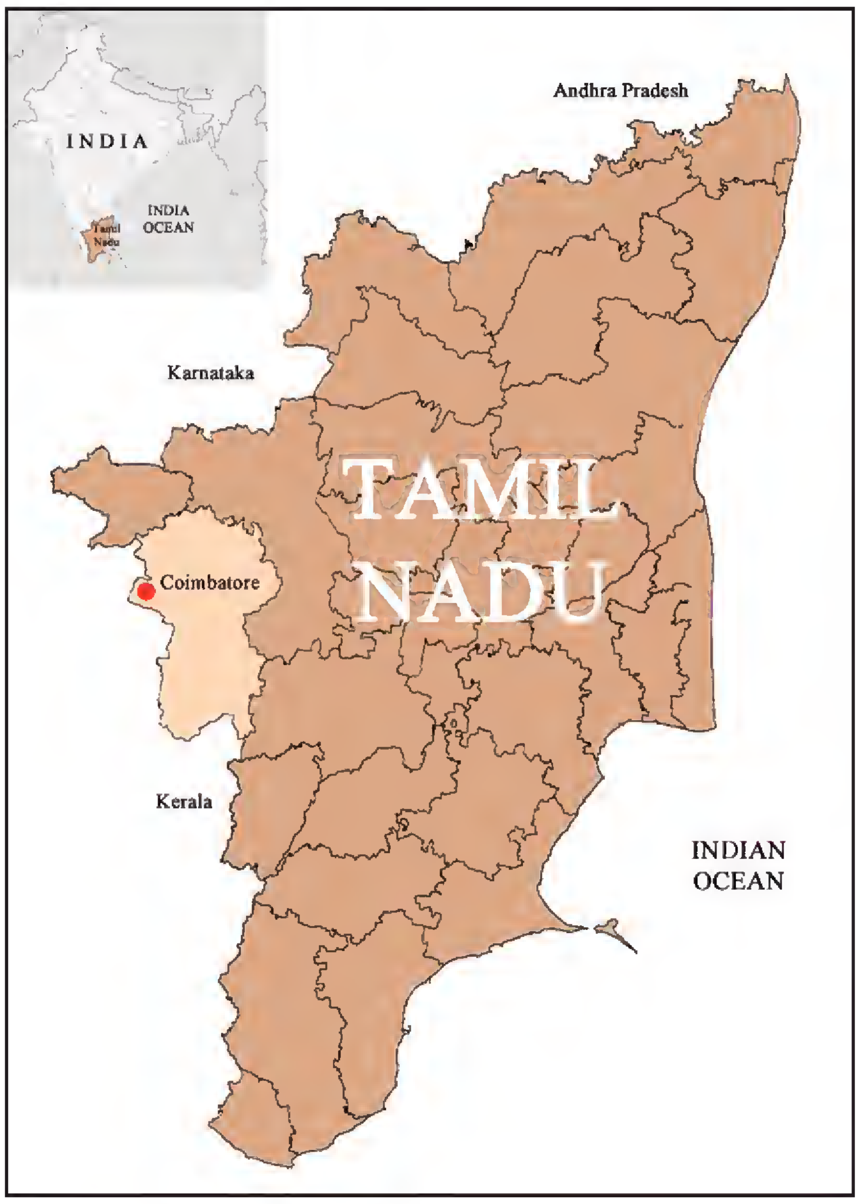

Figure 1. Location of Boluvampatti forests in Coimbatore district of Tamil Nadu, India.

Floristic study

The present study was conducted during 2010–2012 to compile a comprehensive list of invasive alien plant species. Intensive field studies were conducted in a planned manner repeatedly in different seasons in order to document maximum representation of invasive plant species. During the repeated field visits, the observations on field characters such as habit, habitat, spread, important species traits associated with invasiveness were made. Almost the entire forest area was surveyed in order to know the impact of invasiveness on native vegetation in the study area.

During the course of study, the invasive plant species were collected in their natural habitats and filed numbers were assigned to each species. All the collected plant species were identified with the help of regional floras (Gamble & Fischer, 1915–1936; Matthew, 1983; Nair & Henry, 1983; Henry et al.,1987; Chandrabose & Nair, 1988). Plant species collected were dried and herbarium specimens were prepared by using standard methods as suggested by Jain & Rao (1976). The voucher specimens were deposited in the Herbarium of Department of Botany, Bharathiar University, Coimbatore, Tamil Nadu for future reference.

The nativity of the invasive plants has been recorded from the published literature (Chatterji, 1947; Maheswari, 1960; Srivastava, 1964; Matthew, 1969; Maheswari & Paul, 1975; Nayar, 1977; Hajra & Das, 1982; Sharma, 1984; Saxena, 1991; Pandey & Parmer, 1994; Reddy & Raju, 2002; Negi & Hajra, 2007). The modes of introduction of these species were documented from the published literature and categorized according to their economic uses as food, fodder, medicinal and ornamental. Plants were also categorized by life form i.e., herb, shrub, climber and tree. Literature and local people were consulted for use value or anthropogenic use, if any.

RESULTS AND DISCUSSION

The present study was undertaken to identify the diversity of invasive plant species in Boluvampatti forest range, the Southern Western Ghats of Tamil Nadu. A total number of 90 alien plants from 37 families belonging to 74 genera were documented from the study region. They are listed alphabetically in tabular form, followed by author's abbreviation, name of the family, nativity, life form, habitat, uses and voucher specimen number (Table 1). Among these the dicotyledons are represented by 32 families, 67 genera and 83 species; monocotyledons by 5 families, 7 genera and 7 species. All the species listed in this study were also reported as weeds in other countries or as invasive alien plants in most of the regions, and are included in the Global Compendium Weeds (Randall, 2002).

Out of 90 species, only 13 namely *Ageratum conyzoides*, *Amaranthus spinosus*, *Asclepias curassavica*, *Cassia alata*, *Catharanthus roseus*, *Celosia argentea*, *Chenopodium ambrosioides*, *Ipomoea eriocarpa*, *Lantana camara*, *Mirabilis jalapa*, *Passiflora foetida*, *Portulaca oleracea* and *Solanum nigrum* seem to have been introduced deliberately and the rest of them unintentionally through trade exchange including grain import. Further, it has been observed that few species like *Parthenium hysterophorus*, *Lantana camara*,

Eupatorium odoratum, *Prosopis juliflora* and *Ageratum conyzoides* are highly invasive and have invaded on the fringes of forests as well as inside the reserved forests.

On the basis of the nativity of the species, a total of 17 different geographical regions were recorded in the present study. In that, about 72% are contributed by five major geographical regions viz., Tropical America (59%), Tropical Africa (15%), Australia (3%), Europe (4%) and South America (13%) (Fig. 2). It is interesting to note that, most of the invasive species in the study region owe their origin to tropical regions i.e., America (72%), Africa (14%) and Europe (3%). The remaining 28% species were collectively contributed by nine regions.

Habit wise analysis showed that herbs with 70 species (78%) predominate, followed by shrubs (10 species, 11%), climbers (5 species, 6%) and trees (5 species, 5%). Annual plants comprise about 52% of the invasive species and the remaining are perennials. In terms of number of species, Asteraceae were found to be the most dominant family with 15 species among the reported invasive species followed by Amaranthaceae (6 sp.), Convolvulaceae (5 sp.), Caesalpiniaceae and Solanaceae (4 sp. each), Asclepiadaceae, Poaceae, Euphorbiaceae, Malvaceae and Lamiaceae (3 sp. each). The genera with the highest number of invasive species in the study area are *Cassia* and *Ipomoea* (4 sp. each), *Cleome*, *Corchorus* (3 sp. each), *Alternanthera*, *Blumea*, *Calotropis*, *Euphorbia*, *Solanum* and *Tribulus* (2 sp. each).

Invasive alien plant species are used for a variety of functional and aesthetic purposes. Many people who seek to introduce a non-native species into a new habitat do so for an economic reason (McNeely, 2001) and most cases of invasiveness can thus be linked to the intended or unintended consequences of economic activities (Perrings et al., 2002). Commercial use of invasive alien plant species can contribute in uplifting the economic status of poor rural communities (Semenya et al., 2012). For example, *Lantana camara* is being used for basket-making and some other purposes. A search in literature and consultation with local people indicated that several of the invasive species are also used for different purposes for example, the stem of *Malvastrum coromandelianum*, *Sesbania bispinosa* and *Sida acuta* for fibre and

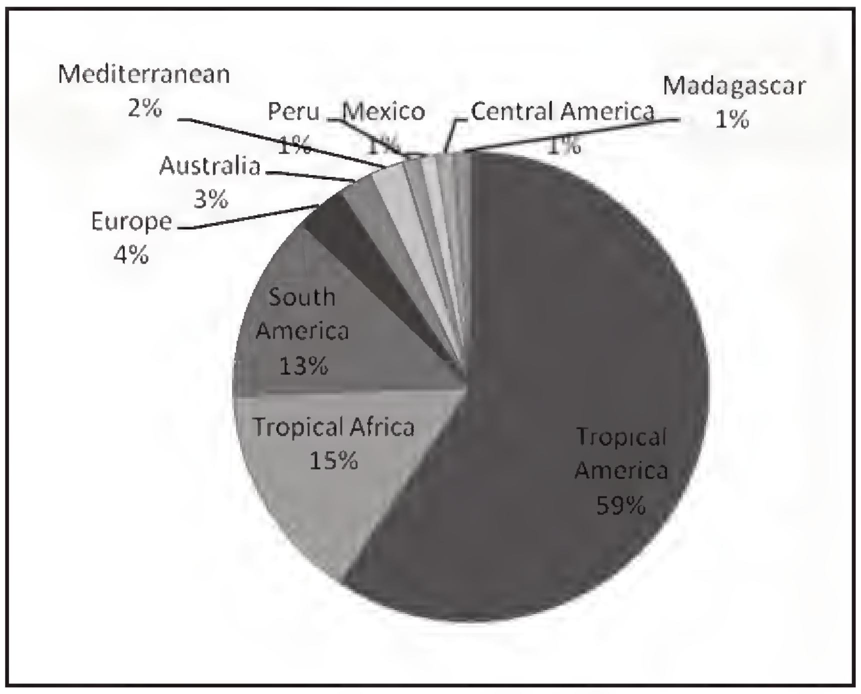

Figure 2. Contribution of different geographical areas to invasive species in the study.

Borassus flabellifer for making hand-held fans (Sekar et al., 2012).

Thirteen invasive species are under consideration for medicinal purposes (Table 2). Several of these are used for adulteration: for example, mustard oil is adulterated with extract from seeds of *Argemone mexicana*. Moreover, some of the species i.e. *Parthenium hysterophorus*, *Lantana camara* and *Prosopis juliflora* have high allelopathic potential and are harmful to natural plant population. These invasive alien species are ready colonizers in disturbed areas and cause considerable ecological damages to natural areas.

CONCLUSION

The results of the present study have shown that most of the exotic plant species currently spreading were intentionally introduced. They have not only disturbed the environment and ecosystem but have also threatened the indigenous flora, as a number of plants are getting rare. There is every possibility that if the invasion of alien species will continue to operate unchecked, the endemic species may get extinct and the germplasm of economic plants may become rare or even be exterminated. Therefore, it is very important to make an effective database for the management of invasive species, and improve the knowledge about their diversity, life form, habitat and uses for further studies.

Name of the species	*Family*	*No.*	*Nativity*	*Life form*	*Habit*	*Uses*
Acacia dealbata Link.	Mimosaceae	1127	Australia	Tree	Perennial	Fuel wood
Acanthospermum hispidum DC.	Asteraceae	1134	Brazil	Herb	Annual	Medicinal
Ageratum conyzoides L.	Asteraceae	1135	Tropical America	Herb	Annual	Medicinal
Alternanthera pungens Humb.	Amaranthaceae	1174	Tropical America	Herb	Perennial	Medicinal
Alternanthera sessilis (L.) DC.	Amaranthaceae	1175	Tropical America	Herb	Perennial	Medicinal, Fodder
Amaranthus spinosus L.	Amaranthaceae	1176	Tropical America	Herb	Annual	Medicinal, Fodder
Argemone mexicana L.	Papaveraceae	1101	South America	Herb	Annual	Medicinal
Asclepias curassavica L.	Asclepiadaceae	1150	Tropical America	Herb	Perennial	Medicinal
Bidens pilosa L.	Asteraceae	1136	Tropical America	Herb	Annual	Medicinal, Fodder
Blumea eriantha DC.	Asteraceae	1137	Tropical America	Herb	Perennial	Fodder
Blumea lacera (Burm. f.) DC.	Asteraceae	1138	Tropical America	Herb	Annual	Medicinal
Borassus flabellifer L.	Arecaceae	1185	Tropical Africa	Tree	Perennial	Fruit edible
Calotropis gigantea (L.) R. Br.	Asclepiadaceae	1151	Tropical Africa	Shrub	Perennial	Medicinal
Calotropis procera (Ait.) R. Br.	Asclepiadaceae	1152	Tropical Africa	Shrub	Perennial	Medicinal
Cassia alata L.	Caesalpiniaceae	1123	South America	Shrub	Perennial	Medicinal
Cassia obtusifolia L.	Caesalpiniaceae	1124	Tropical America	Herb	Perennial	Medicinal
Cassia occidentalis L.	Caesalpiniaceae	1125	South America	Herb	Perennial	Medicinal
Cassia tora L.	Caesalpiniaceae	1126	South America	Herb	Annual	Medicinal
Catharanthus roseus L.	Apocynaceae	1149	Tropical America	Herb	Perennial	Medicinal
Chenopodium ambrosioides L.	Chenopodiaceae	1180	Tropical America	Herb	Annual	Fodder
Chloris barbata (L.) Sw.	Poaceae	1188	Tropical America	Herb	Perennial	Fodder
Chromolaena odorata L.	Asteraceae	1139	Tropical America	Shrub	Perennial	Medicinal
Cleome viscosa L.	Cleomaceae	1104	Tropical America	Herb	Perennial	Medicinal
Cleome gynandra L.	Cleomaceae	1102	Tropical America	Herb	Annual	Medicinal
Cleome monophylla L.	Cleomaceae	1103	Tropical Africa	Herb	Annual	Fodder
Corchorus aestuans L.	Tiliaceae	1110	Tropical America	Herb	Annual	Medicinal
Corchorus tridens L.	Tiliaceae	1111	Tropical Africa	Herb	Annual	Fibre, Fodder
Corchorus trilocularis L.	Tiliaceae	1112	Tropical Africa	Herb	Annual	Fibre
Crotalaria retusa L.	Fabaceae	1119	Tropical America	Herb	Annual	Fodder, Ornamental
Croton bonplandianum Baill.	Euphorbiaceae	1181	South America	Herb	Perennial	Fodder

Table 1. List of invasive plant species in Boluvampatti forests, Coimbatore district of Tamil Nadu, India.

Name of the species	*Family*	*S. No.*	*Nativity*	*Life form*	*Habit*	*Uses*
Cuscuta reflexa Roxb.	Cusutaceae	1158	Mediterranean	Climber	Annual	Medicinal
Croton bonplandianum Baill.	Euphorbiaceae	1181	South America	Herb	Perennial	Fodder
Cuscuta reflexa Roxb.	Cusutaceae	1158	Mediterranean	Climber	Annual	Medicinal
Cyperus difformis L.	Cyperaceae	1187	Tropical America	Herb	Annual	Fodder
Datura metel L.	Solanaceae	1159	Tropical America	Shrub	Perennial	Medicinal
Digera muricata (L.) Mart.	Amaranthaceae	1178	South West Asia	Herb	Annual	Medicinal
Echinochloa colona (L.) Link.	Poaceae	1189	South America	Herb	Annual	Fodder
Echinops echinatus Roxb.	Asteraceae	1140	Afghanistan	Herb	Annual	Medicinal
Eclipta prostrata (L.) Mant.	Asteraceae	1141	Tropical America	Herb	Annual	Medicinal, Ornamental
Emilia sonchifolia (L.) DC.	Asteraceae	1142	Tropical America	Herb	Annual	Medicinal
Euphorbia cyathophora Murray	Euphorbiaceae	1182	Tropical America	Herb	Annual	Ornamental
Euphorbia hirta L.	Euphorbiaceae	1183	Tropical America	Herb	Annual	Medicinal
Evolvulus nummularis L.	Convolvulaceae	1153	Tropical America	Herb	Perennial	Fodder
Gomphrena serrata L.	Amaranthaceae	1179	Tropical America	Herb	Annual	Fodder
Hyptis suaveolens (L.) Poit.	Lamiaceae	1170	Tropical America	Herb	Annual	Medicinal
Indigofera trita L.	Fabaceae	1120	Tropical Africa	Shrub	Perennial	Fodder
Ipomoea eriocarpa R. Br.	Convolvulaceae	1154	Tropical Africa	Herb	Annual	Medicinal
Ipomoea obscura (L.) Ker.-Gawal.	Convolvulaceae	1155	Tropical Africa	Climber	Perennial	Medicinal
Ipomoea pes-tigridis L.	Convolvulaceae	1156	Tropical Africa	Climber	Annual	Medicinal
Ipomoea staphylina Roem. et Schult.	Convolvulaceae	1157	Tropical Africa	Climber	Annual	Fodder
Lantana camara L.	Verbenaceae	1168	Tropical America	Herb	Perennial	Medicinal, Ornamental
Leonotis nepetiifolia (L.) R.Br.	Lamiaceae	1171	Tropical Africa	Herb	Annual	Medicinal
Malvastrum coromandelia-num (L.) Garcke	Malvaceae	1106	Tropical America	Herb	Annual	Medicinal, Fibre
Martynia annua L.	Pedaliaceae	1164	Tropical America	Herb	Perennial	Medicinal
Melia azedarach L.	Meliaceae	1117	India	Tree	Perennial	Medicinal
Mikania micrantha Kunth.	Asteraceae	1143	Tropical America	Climber	Annual	Medicinal
Mimosa pudica L.	Mimosaceae	1128	Brazil	Herb	Perennial	Medicinal
Mirabilis jalapa L.	Nyctaginaceae	1173	Peru	Herb	Annual	Ornamental
Ocimum americanum L.	Lamiaceae	1172	Tropical America	Herb	Annual	Ornamental
Opuntia stricta Haw.	Cactaceae	1132	Tropical America	Shrub	Perennial	Fruits edible

Table 1. List of invasive plant species in Boluvampatti forests, Coimbatore district of Tamil Nadu, India.

Name of the species	*Family*	*S. No.*	*Nativity*	*Life form*	*Habit*	*Uses*
Oxalis corniculata L.	Oxalidaceae	1116	Europe	Herb	Perennial	Vegetable
Parthenium hysterophorus L.	Asteraceae	1144	North America	Herb	Annual	Fodder
Passiflora foetida L.	Passifloraceae	1131	South America	Climber	Perennial	Medicinal
Pedalium murex L.	Pedaliaceae	1165	Tropical America	Herb	Perennial	Medicinal
Peristrophe paniculata (Forssk.) Brummit	Acanthaceae	1166	Tropical America	Herb	Annual	Medicinal
Physalis minima L.	Solanaceae	1160	Tropical America	Herb	Annual	Medicinal
Pilea microphylla (L.) Liebm.	Urticaceae	1184	South America	Herb	Annual	Vegetable, Ornamental
Portulaca oleracea L.	Portulacaceae	1105	South America	Herb	Annual	Medicinal, Vegetable
Prosopis juliflora (Sw.) DC.	Mimosaceae	1129	Mexico	Tree	Perennial	Fuel wood
Ruellia tuberosa L.	Acanthaceae	1167	Tropical America	Herb	Annual	Ornamental
Scoparia dulcis L.	Scrophulariaceae	1163	Tropical America	Herb	Perennial	Medicinal
Sesbania bispinosa (Jacq.) Wight.	Fabaceae	1121	Tropical America	Shrub	Annual	Fibre, Vegetable
Sida acuta Burm. f.	Malvaceae	1107	Tropical America	Herb	Annual	Medicinal, Fibre
Solanum nigrum L.	Solanaceae	1161	Tropical America	Herb	Annual	Medicinal, Edible
Solanum torvum Sw.	Solanaceae	1162	Tropical America	Shrub	Perennial	Medicinal
Sonchus asper (L.) Hill	Asteraceae	1145	Mediterranean	Herb	Annual	Medicinal
Sorghum halepense (L.) Pers.	Solanaceae	1190	Tropical America	Herb	Perennial	Fodder
Spermacoce hispida L.	Rubiaceae	1133	Tropical America	Herb	Perennial	Medicinal
Spilanthes acmella (L.) Murr.	Asteraceae	1146	South America	Herb	Annual	Fodder
Stachytarpheta jamaicensis	Verbenaceae	1169	Tropical America	Herb	Annual	Medicinal
Stylosanthes hamata L.	Febaceae	1122	Tropical America	Herb	Perennial	Fodder
Synedrella nodiflora (L.) Gaertn.	Asteraceae	1147	West Indies	Herb	Annual	Ornamental
Tribulus lanuginosus L.	Zygophyllaceae	1114	Tropical America	Herb	Annual	Medicinal
Tribulus terrestris L.	Zygophyllaceae	1115	Tropical America	Herb	Perennial	Medicinal
Tridax procumbens L.	Asteraceae	1148	Central America	Herb	Perennial	Medicinal
Triumfetta rhomboidea Jacq.	Tiliaceae	1113	Tropical America	Herb	Annual	Medicinal
Turnera ulimifola L.	Turneraseae	1130	Tropical America	Herb	Annual	Ornamental
Typha angustata Bory et Chaup.	Typhaceae	1186	Tropical America	Herb	Perennial	Ornamental
Urena lobata L.	Malvaceae	1108	Tropical Africa	Shrub	Perennial	Fibre
Waltheria americana L.	Sterculiaceae	1109	Tropical America	Herb	Perennial	Medicinal
Ziziphus mauritiana Lam.	Rhamnaceae	1118	Australia	Tree	Perennial	Fruits edible

Table 1. List of invasive plant species in Boluvampatti forests, Coimbatore district of Tamil Nadu, India.

S. No.	*Name of the plant*	*Part(s) used*	*Medicinal uses*
1.	*Ageratum conyzoides* L.	Leaves	Leaf-juice used in healing the wounds, sores and skin diseases.
2.	*Alternanthera sessilis* (L.) R. Br.	Whole plant	Plants used in snake-bite.
3.	*Amaranthus spinosus* L.	Whole plant	Plants used in snake-bites, bowel and kidney complaints.
4.	*Argemone mexicana* L.	Whole plant	Roots used in scorpion sting.
5.	*Asclepias curassavica* L.	Leaves and roots	Roots used in curing piles. Leaf juice used for hemorrhages.
6.	*Bidens pilosa* L.	Flower	Dried flowers buds used in toothache.
7.	*Calotropis gigantea* (L.) R. Br.	Latex	Latex used as disinfectant to wounds.
8.	*Cassia tora* L.	Leaves and seeds	Leaves and seeds used as skin diseases.
9.	*Catharanthus roseus* (L.) G. Don.	Root	The roots are great commercial value in medi-
10.	*Celosia argentea* L.	Seeds	Seeds used in blood disease and mouth sores.
11.	*Cleome gynandra* L.	Whole plant	Plants used in scorpion-sting and snake-bite.
12.	*Digera muricata* (L.) Mart.	Flowers and seeds	Flowers and seeds used in urinary troubles.
13.	*Eclipta prostrata* L.	Root	Roots used as antiseptic to ulcers and wounds in cattle.
14.	*Emilia sonchifolia* (L.) DC.	Leaves	Leaf-juice used in curing wounds and sore ears.
15.	*Euphorbia hirta* L.	Whole plant	Plants used in bowel complaints for children.
16.	*Ipomoea eriocarpa* R. Br.	Whole plant	Plants used in the treatment of rheumatism and headache
17.	*Ipomoea obscura* (L.) Ker-Gawl.	Leaves	Leaves used in the treatment of ulcers.
18.	*Ipomoea pes-tigridis* L.	Leaves	Leaves used as an antidote to dog-bite; also used in boils.
19.	*Martynia annuva* L.	Leaves	Leaves used in epilepsy.
20.	*Melia azedarach* L.	Leaves and seeds	Leaves used as anthelmintic; seeds used in rheumatism.
21.	*Mimosa pudica* L.	Root	Roots used in asthma, dysentery, etc.
22.	*Ocimum americanum* L.	Whole plant	Plants used in fever.
23.	*Oxalis corniculata* L.	Leaves	Leaves used in fever.
24.	*Passiflora foetida* L.	Leaves	Leaves used in headache.
25.	*Pedalium murex* L.	Leaves and fruits	Leaves used in gonorrhoea; fruits used in spermatorrhoea.
26.	*Physalis minima* L.	Leaves	Leaf juice used in earache.
27.	*Scoparia dulcis* L.	Whole plant	Plants used in toothache.
28.	*Solanum nigrum* L.	Leaves	Leaf-juice used in chronic enlargement of the liver and dysentery.
29.	*Spilanthes acmella* (L.) DC.	Leaves	Leaves used to treat toothache and skin diseases.
30.	*Stachytarpheta jamaicensis* (L.) Vahl.	Whole plant	Plants used in fever, rheumatism and dysentery.

Table 2. List of medicinally useful invasive species in the study.

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REFERENCES

Chandra Sekar K., 2012. Invasive alien plants of Indian Himalayan Region - Diversity and Implication. American Journal of Plant Science, 3: 177–184.

Chandra Sekar K., Manikandan R. & Srivastava S.K., 2012. Invasive alien plants of Uttarakhand, Himalaya. Proceedings of Natural Academic Sciences of India. doi 10. 1007/s40011-012-0040-2.

Chandrabose M. & Nair N.C., 1988. Flora of Coimbatore. Bishen Singh Mahendra Pal Singh, Dehra Dun.

Chatterji D., 1947. Influence of east Mediterranean regions flora on that of India. Science Culture, 13: 9–11.

Corlett R.T., 1988. The naturalized flora of Singapore. Journal of Biogeography, 15: 657–663.

Dogra K.S., Kohli R.K. & Sood S.K., 2009. An assessment and impact of three invasive species in the Shivalik hills of Himachal Pradesh, India. International Journal of Biodiversity and Conservation, 1: 4–10.

Drake S.J., Weltzin J.F. & Parr P., 2003. Assessment of non-native invasive plant species on the United States Department of Energy Oak Ridge National Environmental Research, Australia. Castanea, 68: 15–30.

Ehrlich P.R. & Wilson E.O., 1991. Biodiversity studies: Science and Policy. Science, 253: 758–762.

Enmotto T., 1999. Naturalized weeds from foreign countries into Japan. In: Yano E., Matsuo M., Shiyomi M. & Andow.D.A. (Eds.). Biological invasion of ecosystem by pests and beneficial organisms. National Institute of Agro-Environmental Science, Tsukuba, pp. 1–14.

Gamble J.S. & Fischer C.E.C., 1915-1936. Flora of Presidency of Madras. Vols. 1–3. Reprint ed. 1957. Adlard & Sons Ltd., London.

Hajra P.K. & Das B.K., 1982. Vegetation of Gangtok with special reference to alien plants. Indian Forum, 107: 554–566.

Henry A.N., Kumari G.R. & Chitra V., 1987. Flora of Tamil Nadu, India. Series I (Analysis): Vols. II-III. Botanical survey of India, Southern Circle, Coimbatore, Tamil Nadu.

Hobbs R.J. & Humphries S.E., 1995. An integrated approach to the ecology and management of plant invasions. Conservational Biology, 9: 761–770.

Holdgate M., 1996. The ecological significance of biological diversity. Ambio, 25: 409–416.

Huang Q.Q., Wu J.M., Bai Y.Y., Zhou L. & Wang G.X., 2009. Identifying the most noxious invasive plants in China: role of geographical origin, life form and means of introduction. Biodiversity Conservation, 18: 305–316.

Jain S.K. & Rao R.R., 1976. A handbook of field and herbarium methods. Today & Tomorrow Publishers, New Delhi.

Khanna K.K., 2009. Invasive alien angiosperms of Uttar Pradesh. Biological Forum - An International Journal, 1: 41–46.

Levine S.A., 1989. Analysis of risk for invasions and control program. In: Drake J. A., Mooney H.A., Di Castri F., Grooves R.H., Druger F.J., Rejmanek M. & Williamson M. (Eds.). Biological invasion: A Global Perspective. John Wiley & Sons, New York, pp. 425–435.

Lubchenco J., Olson A.M., Brubaker L.B., Carpenter S.R., Holland M.M., Hubbell S.P., Levin S.A., Macmahon J.A., Matson P.A., Melillo J.M., Mooney H.A., Peterson C.H., Pulliam H.R., Real L.A., Regal P.J. & Risser, P.G., 1991. The sustainable biosphere initiative: an ecological research agenda. Ecology, 72: 371–412.

Mack R.N., Simberloff D., Lonsdale W.M., Evans H., Clout M. & Bazzaz F.A., 2000. Biotic invasions: causes, epidemiology, global consequences and control. Ecological Applications, 10: 689–710.

Maheswari J.K. & Paul S.R., 1975. The alien flora of Ranchi. Journal of Bombay Natural Historical Society, 72: 158–188.

Maheswari J.K., 1960. Studies on the naturalized flora of India. In: Maheshwari, P., Johri B.M. & Vasil I.K. (Eds.). Proceedings of the Summer School of Botany, pp. 156–170.

Matthew K.M., 1969. Alien flora of Kodai Kanal and Palni Hills. Recordings of the Botanical Survey of India, 20: 1–241.

Matthew K.M., 1983. The flora of Tamilnadu Carnatic. The Rapinat Herbarium, Tiruchirapalli, Tamil Nadu, India.

McNeely J.A., 2001. An introduction to human dimensions of invasive alien species. ISSG, IUCN.

Meyer J.Y., 2000. Preliminary review of the invasive plants in the Pacific islands. In: Shreley G. (Ed.). Invasive species in the Pacific: a technical review and draft regional strategy. South Pacific Regional Environmental Programme, Samoa, pp. 85–114.

Mooney H.A. & Hobbs R.J., 2000. The exotic flora of Rajasthan. Journal of Economic & Taxonomic Botany, 18: 105–121.

Myers N., Mittermeier R.A., Mittermeier C.G., Da Fonseca G.A. & Kent J., 2000. Biodiversity hotspots for conservation priorities. Nature, 403: 853–858.

Nair M.P. & Henry A.N., 1983. Flora of Tamil Nadu, India. Series I (Analysis): Vol. I. Botanical survey of India, Southern Circle, Coimbatore, Tamil Nadu.

Nayar M.P., 1977. Changing patterns of the Indian flora. Bulletin Botanical Survey of India, 19: 145–154.

Negi P.S. & Hajra P.K., 2007. Alien flora of Doon Valley, North West Himalaya. Current Science, 92: 968–978.

Pandey R.P. & Parmer P.J., 1994. The exotic flora of Rajasthan. Journal of Economic and Taxonomic Botany, 18: 105–135.

Perrings C., Williamson M., Barbier E.B., Delfino D., Dalmazzone S., Shogren J., Simmons P. & Watkinson A., 2002. Biological invasion risks and the public good: an economic perspective. Conservational Ecology, 6: 1.

Randall R.P. 2002. A Global Compendium of Weeds. Shannon Books, Australia.

Reddy C.S. & Raju V.S., 2002. Additions to the weed flora of Andhra Pradesh, India. Journal of Economic & Taxonomic Botany, 26: 195–208.

Reddy C.S. 2008. Catalogue of invasive alien flora of India. Life Science Journal, 5: 84–89.

Richardson D.M., Pysek P., Rejmanek M., Barbour M.G., Panetta F.D. & West C.J., 2000. Naturalization and invasion of alien plants: Concepts and definitions. Diversity and Distribution, 6: 93–107.

Saxena K.G., 1991. Biological invasion in the Indian sub-continent: Review of invasion by plants. In: Ramakrishnan P.S. (Ed.). Ecology of Biological Invasion in the Tropics. International Scientific Publications, New Delhi, pp. 53–73.

Semenya S., Milingoni P.T. & Martin T.P., 2012. Invasive alien plant species: a case study of their use in the Thulamela local municipality, Limpopo Province, South Africa. Scientific Research Essays, 7: 2363–2369.

Sharma B.D., 1984. Exotic flora of Allahabad. Botanical Survey of India, Dehra Dun.

Sharma G.P., Singh J.S. & Raghubanshi A.S., 2005. Plant invasions: emerging trends and future implications. Current Science, 88: 726–734.

Simberloff D., Parker I.M. & Windle P.M., 2005. Introduced species policy, management and future implications. Current Science, 88: 726–734.

Singh J.S., 2002. The biodiversity crisis: a multifaceted review. Current Science, 82: 638–647.

Singh K.P., Shukla A.N. & Singh J.S., 2010. State-level inventory of invasive alien plants, their source regions and use potential. Current Science, 90: 107–114.

Srivastava J.D., 1964. Some tropical American and African weeds that have invaded the state of Bihar. Journal of Indian Botanical Society, 43: 102–112.

Subramanian K.N., 1959. Observations on the Flora of Boluvampatti forests, Coimbatore Taluk. Bulletin Botanical Survey of India, 1: 127–137.

Subramanian K.N., 1996. Further contributions to the flora of Boluvampatti Valley forests, Coimbatore District, Madras State. Indian Forester, 92: 39–50.

Tilman D., 2000. Causes, consequences and ethics of biodiversity. Nature, 405: 208–211.

Vila M. & Weiner J., 2004. Are invasive plant species better competitors than native plant species? Evidence from pair-wise experiments. Oikos, 105: 229–238.

Walck J.L., Baskin J.M. & Baskin C.C., 1999. Effects of competition from introduced plants on establishment, survival, growth and reproduction of the rare plant *Solidago shortii* (Asteraceae). Biological Conservation, 88: 213–219.

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Measuring species diversity for conservation biology: incorporating social and ecological importance of species

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ABSTRACT A new Importance-Diversity Index is proposed as an enhancement to the traditional Shannon diversity index. The proposed index incorporates an importance weight to each species of organisms found in an ecosystem. The importance weights are derived from four (4) main domains deemed important in conservation biology, namely: (1) species endemicity, (2) economic utility, (3) functional role in the ecosystem, and (4) risk status of the species (threatened or endangered). Scenario simulations show that the new index aids in conservation decisions particularly in cases where the Shannon's indices of the ecosystems are equal or near equal or even in situations where the Shannon's index clearly identifies a site but the relative importance of the species found in other sites is heavier.

KEY WORDS Conservation biology; diversity-importance index; diversity index; Shannon Index.

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INTRODUCTION

Current competing uses of finite resources vis-a-vis protection of biological diversity has forced society to make difficult decisions in balancing species conservation and economic development. Given this situation, conservation biology has been in the forefront in the protection of biological resources, ecosystems and habitat against pressures imposed by economic progress and urbanization which often results into reduction of biological diversity. Furthermore, decisions with regard conservation prioritizations depend on the biodiversity of the area.

Several measures of biodiversity have been proposed and used with varying applications depending on the level and scale of diversity. One of the most commonly used measures of biodiversity is the Shannon Index (Spellerberg & Fedor, 2003), wherein both the species richness (i.e. number of species) and species abundance (i.e. number of individuals within the same species) are incorporated in the function. High Shannon Index value (highly diverse areas) are prioritized, less diverse areas are less prioritized or converted to other economic uses.

Such mind set is acceptable if we assume that all species present in the area do not have additional importance values. However, there are species that are endemic (or rare), some are classified as either endangered or threatened, and others play important functions in the ecosystem (e.g. keystone species). Duelli & Obrist (2003) identified these as among the concordant indicators representing three value systems, namely, conservation, ecology, and biological control. These values should be given considerations in measuring indices for conservation biology. On the other hand, the Shannon Index, as like most other indices of diversity existing to date, treats

species equally and does not incorporate these "important values". Hence, the Shannon Biodiversity Index is not designed to detect the presence of endemic (or rare) species nor is it sensitive to species that are classified as threatened or endangered. Consideration for "additional values" is imperative if we are to meaningfully protect our biological resources.

This paper proposed a new index which incorporates "importance values" in measuring diversity index for conservation of biological resources and habitats. It has immense policy implications particularly in making sure that species that have values, which are otherwise not being considered in other indices, be given priority for protection and conservation.

The Shannon's Diversity Index

A popular diversity index used in Biology is the Shannon's Index given by:

1) $H = -\sum_{i=1}^{R} P_i \ln P_i$

where P_i is the proportion of individuals found in an ecosystem and R is the number of individual types. The index, therefore, takes into a count both abundance and richness (R) in the competition. To maximize H, we can either increase R or make the distribution of the individual types more even e.g. $P_i = 1/R$ for all i. Thus:

2) $H_{max} = -\sum_{i=i}^{R} \frac{1}{R} \ln \frac{1}{R} = \ln R$

Where H tends to infinity as $R \rightarrow \infty$. High values of H indicate higher biodiversity while low values of H reflect the opposite situation. As such, (1) is often used as a criterion for determining which of several competing ecosystems need to be protected (conserved) and which can be developed. Ecosystems that have high biodiversity (H) are often declared as protected areas for conservation purposes. The general equation of diversity is often written in the form:

$${}^{q}D = \left(\sum_{i=1}^{R} p_i^{q}\right)^{1/(1-q)}$$

The term inside the parentheses is called the basic sum. Some popular diversity indices correspond to the basic sum as calculated with different values of q. For diversity of order one, an alternative equation is:

$${}^{1}D = exp\left(-\sum_{i=1}^{R} p_i \ln p_i\right) = exp\,(H')$$

where H' is the Shannon's index as calculated with natural logarithms.

Nonetheless, it is quite possible that an ecosystem, say A, has lower Shannon's index than another ecosystem, B, yet A is the habitat of "important" biological species endemic in it. In this case, it may be preferable to protect A than B despite the higher Shannon's index of the latter than the former. An index that incorporates the notion of "importance" is, therefore, a necessary tool for conservation biology.

A Model for Importance Values

In this Section, we define the notion of relative importance (I_j) of the jth species. (j = 1, 2, …, R) found in an ecosystem. Conservation biology literature (Hurlbert, 1971; Duelli & Obrist, 2003; Spellerberg & Fedor, 2003; Jiang & Yin, 2013;) suggests four (4) domains of relative importance, namely: (1) Species endemicity, (2) Economic importance, (3) Functional Role, and (4) Species risk status (threatened or endangered).

Species endemicity refers to a situation where a particular species of biological organism can only be found in a particular habitat and nowhere else. Species' economic importance refers to the economic utility of the species. The species' functional role in the ecosystem alludes to specific biological function of the organism viz. whether or not it is a keystone species. Finally, the risk status of the species refers to its being a threatened or an endangered species which necessitates protection and conservation.

The domains are assigned individual weights, W_j, for the jth domain. A relative importance I_j score for the jth species is obtained from:

3) $I_j = W_1 + W_2 + W_3 + W_4$

where:

$0 \leq I_j \leq 1, \quad 0 \leq W_j \leq 1$

Domain	Relative Importance
1. Species endemicity	0.50
2. Economic utility	0.20
3. Ecosystem Function	0.20
4. Risk Status (threatened/endangered)	0.10
Total	**1.00**

Table 1. A priori relative importance weights.

Prior to the survey, a relative importance table is constructed such as typically illustrated in Table 1.

The weights assigned to the domains reflect the researchers' bias and are inherently subjective. Thus, an environmental economist would probably assign higher weight to domain 2 while a conservationist would perhaps give greater weight to (1), (2), (3) and (4).

A perfectly unbiased weight assignment assigns equal score to each domain viz. 0.25.

A Diversity-Importance Index

Let there be R types of organisms (species, genera etc.) in an ecosystem. The proportions of each type of organisms are given by $P_1, P_2, \ldots, P_R$. To each type of organisms, we assign relative importance weight $I_1, I_2, \ldots, I_R$. Let:

4) $q_j = P_j I_j^{P_j} \quad , j = 1, 2, \ldots R$

The equality in (4) is defined as the "basic diversity-importance information number (DIIN)." Note that $0 \leq q_j \leq 1$.

Further, q_j incorporates both the diversity measure (P_j) and the importance measure (I_j). Using q_j, we define the Diversity-Importance Index as:

5) $DI = -\sum_{i=1}^{R} q_j \ln q_j$.

or:

6) $-\sum_{i=1}^{R} (P_j I_j^{P_j}) \ln (P_j I_j^{P_j}) \quad , \sum_j P_j = 1$

Equation (6) can be written in a more symmetric fashion as:

7) $DI = -\sum_{i=1}^{R} I_j^{P_j} P_j \ln P_j - \sum_{i=1}^{R} I_j^{P_j} P_j^{2} \ln I_j$

Since $0 \leq Pj \leq 1, 0 \leq Ij \leq 1$, it follows that DI ≥ 0. Equation (7) is maximized when $Pj = 1/R$ and $Ij = 1/R$ for all j.

In this case, (7) becomes:

$$DI_{max} = (\tfrac{1}{R})^{\frac{1}{R}} \ln R \, [1 + \tfrac{1}{R}]$$

and:

$(\frac{1}{R})^{\frac{1}{R}} \rightarrow 1$ as $R \rightarrow \infty$, hence $DI_{max} \rightarrow \infty$.

The function (8) monotonically increases with increasing richness R and uniformly equal importance values. That is, an ecosystem that is diverse with equally important species composition will have high DI values.

Scenarios and Illustrative Examples

A maximum of five (5) species (R = 5) are observed in two (2) sites A and B. The purpose of the environmental assessment is to decide on which site to protect and which site is open for development.

Three (3) experts were asked to construct the Relative Importance Table (RIT). The experts' ratings were averaged out to produce the RIT as shown in Table 2.

Domain	Weight
1. Species endemicity	0.40
2. Economic utility	0.30
3. Ecosystem Function	0.20
4. Risk Status	0.10
Total	**1.00**

Table 2. Relative importance table.

Scenario 1: Equal Shannon's Diversity Index

In this scenario, the traditional Shannon's Index are equal for the two (2) sites (sites A and B) but the Diversity-Importance Indices are different.

A specific illustrative numerical example is given in Table 3.

Species	IV	Pi (A)	Pi (B)
a	0.40	0.25	0.00
b	0.20	0.25	0.25
c	0.20	0.25	0.25
d	0.15	0.25	0.25
e	0.05	0.00	0.25
Total	**1.00**	**1.00**	**1.00**
DI Index		**1.20871**	**1.13997**
H Index		**1.38629**	**1.38629**

Table 3. Illustrative Example for equal Shannon index.

Since the Shannon index of two sites A and B are the same, traditional conservation principles will not be able to decide which site to conserve and which site to develop. However, since the Diversity-Importance (DI) index of site A is greater than that of site B in this case, this means that it makes more sense to conserve site A. Species a which has the highest importance value is not found in B but is found in A. Moreover, species e which is of least importance is absent in A but found in B.

Scenario 2: Unequal Shannon's Diversity Index

In this scenario, the Shannon's indices are unequal for the two sites which would have led to a decision to choose the site with greater H index for conservation, shown in Table 4.

Species	IV	Pi (A)	Pi (B)
a	0.40	0.40	0.20
b	0.30	0.20	0.20
c	0.10	0.10	0.20
d	0.10	0.15	0.20
e	0.10	0.15	0.20
Total	1.00	1.00	1.00
DI Index		1.08585	1.07449
H Index		1.20323	1.28755

Table 4. Unequal Shannon index.

The traditional conservation choice would be site B because of its higher Shannon index (H=1.28755). However, species a which has the highest importance value is found in greater abundance in site A than in site B. For this reason, it makes more practical sense to protect site A than site B as evidenced by the higher DI value of DI =1.085853 for the former site than the corresponding DI value for the latter site which is DI =1.07449.

Scenario 3: Equal Importance Values

If the species are of equal importance, then the decision criterion reduces to a decision based only on the Shannon index; see Table 5 for a typical situation.

Species	IV	Pi(A)	Pi(B)
a	0.20	0.40	0.20
b	0.20	0.30	0.20
c	0.20	0.10	0.20
d	0.20	0.10	0.20
e	0.20	0.10	0.20
Total	1.00	1.00	1.00
DI Index		1.05951	1.11983
H Index		1.18823	1.28755

Table 5. Species with equal importance value.

As expected, the Shannon diversity index is higher for site B than for site A. The DI index likewise is higher for B than for A.

In conclusion, the proposed Diversity-Importance Index is an important aid to conservation biologists in situations when the Shannon Diversity Index (based only on abundance and richness) provides ambiguous or impractical results.

REFERENCES

Duelli P. & Obrist M.K., 2003. Biodiversity indicators: the choice of values and measures. Agriculture, Ecosystems and Environment, 98: 87–98.

Hurlbert S.H., 1971. The non-concept of species diversity: a critique and alternative parameters. Ecology, 52: 577–586.

Jiang B. & Yin J., 2013. Ht-index for quantifying the fractal or scaling structure of geographic features. Annals of the Association of American Geographers.

Spellerberg I.F & Fedor P.J., 2003. A tribute to Claude Shannon (1916–2001) and a plea for more rigorous use of species richness, species diversity and the "Shannon-Weiner" Index. Global Ecology & Biogeography, 12: 177–179.

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Herpetofaunal inventory of Kuriat and Jbel islets (Tunisia)

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ABSTRACT The present paper provides the results of the herpetological investigations carried out on the Kuriat Archipelago, in the Khnis Bay, and the islet of Jbel, off the harbor of Echebba. Six reptile species on the whole have been found on the studied islets. *Tarentola fascicularis* (Daudin, 1802), familia Phyllodactylidae, occurring on Great Kuriat, and *Trachylepis vittata* (Olivier, 1804), familia Scincidae, detected on all the three islets, are recorded for the first time for the islands of Tunisia.

KEY WORDS Reptiles; faunal list; new records; *Tarentola fascicularis*; *Trachylepis vittata*; islands; Tunisia.

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INTRODUCTION

Within the framework of the international program Mediterranean Small Islands Initiative PIM (www.initiative-pim.org), in 2014 March,we had the opportunity to take part to a scientific mission for the naturalistic exploration of the islets distributed along the central sector of the Tunisian shoreline. During this mission were visited Great Kuriat (or Qûrya El Kabira) and Small Kuriat (or Qûrya Essaghira), that form a small archipelago in the Khnis Bay; and Jbel, in front of the harbor of Echebba.

Except for the record of the nesting of loggerhead sea turtle, *Caretta caretta* Linnaeus, 1758, (Reptilia Cheloniidae) on Kuriat Archipelago (Jribi et al., 2006), no data on their herpetofauna are given in literature.

The aim of this paper is therefore to provide the first information about the occurrence of terrestrial reptiles on these islets, with some comments on their distribution.

MATERIAL AND METHODS

Study area

The Kuriat (Qûrya, or Kuriate) Archipelago lies in the Khnis Bay, 16 km off the Cape of Monastir, and includes two islets: Great Kuriat or Qûrya El Kabira (35°47'49"N, 11°02'01"E) and Small Kuriat or Qûrya Essaghira, also called Conigliera (35°46'06"N, 11°00'26"E). The surface is 2.7 and 0.7 km^2 respectively. Both are characterized by a flat morphology, with a maximum elevation of less than 5 m a.s.l., and are formed by limestone substrate overlain by calcareous and sandstone crusts (Oueslati, 1995). Along the coastline, there are also sandy dunes and thick deposits of organic matter (sea-grass litter). The islets lie in the semi-arid superior bioclimatic belt, with an annual precipitation of 300-400 mm (Posner, 1988). Salt-marsh plant communities (Salicornietea) are widely distributed around the low lands (sebkhas), alternated by bare sandy areas,while agarrigue with scattered

shrubs occupies the calcareous outcrops (Posner, 1988). Over-population of gulls and intense grazing, due to the massive occurrence of introduced goats (only on Great Kuriat) and rabbits (in both islands), seem to be the main anthropogenic factors which affected the structure of the vegetation.

Kuriat are uninhabited, except for a small military out post in the light house of the larger island. However, several historical sources attest their more intense frequentation in past (Scalia, 1984), which is also evidenced by the ruins of a Punic port and of a fishermen settlement, respectively, on Great and Small Kuriat.

Jbel (35°12’26”N, 11°10’00”E) is the outermost islet of a micro-archipelago located near the harbor of Echebba, which includes also the larger islet Gataya (where however no herpetofauna has been found). Jbel has a surface of 0.09 km^2 and a maximum elevation of 2 m a.s.l. Despite its proximity to the mainland, from which is only 1.7 km, it is certainly the less anthropized site among those visited and that characterized by a strong environmental homogeneity, due to the almost exclusive covering of halo-psammophilous vegetation and sea-grass litter on the sandy substrate.

Kuriat and Jbel (Fig. 1) are continental islets and lie in the isopleth of -20 m, therefore their isolation from the mainland should be occurred in a very recent time (see Oueslati, 1995; Lambeck & Purcell, 2005).

Field work

Field work was done from 27 to 29 March 2014, spending one day on each island; furthermore, Great Kuriat was visited also nocturnally. We carried out visual encounter surveys as well as active searching by lifting stones and by checking the potential shelters of animals. All the finding specimens have been identified, photographed and released at the place of capture. Species identification was done following the keys given by Schleich

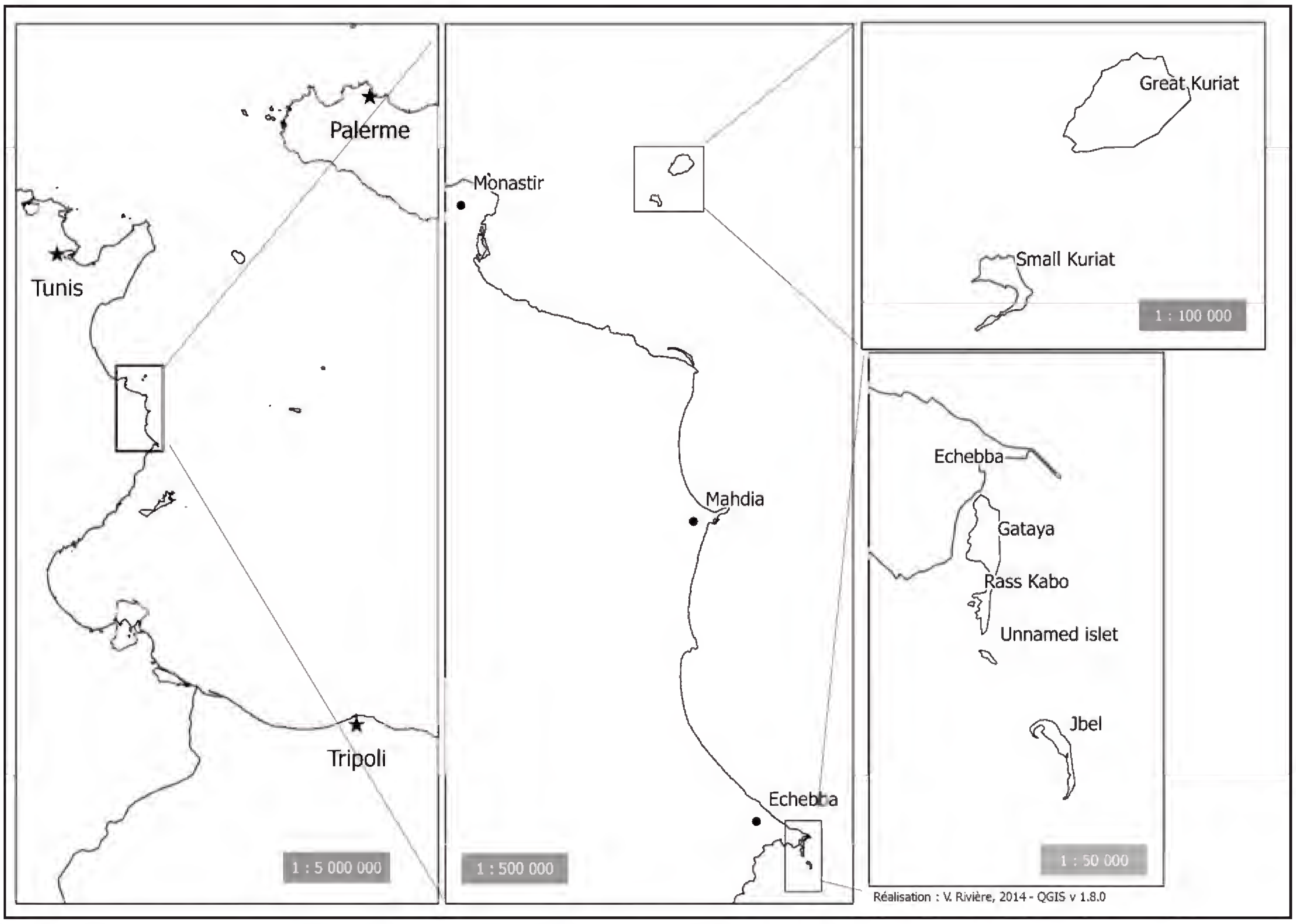

Figure 1. Geographical setting of the study area.

et al. (1996). For Phyllodactylidae and Lacertidae were also used those given by Joger (1984) and Szczerbak (1989), respectively.

Herpetofaunal data

The nomenclature follows Sindaco & Jeremčenko (2008) and Sindaco et al. (2013), except for the species formerly included in the genus *Mabuya* Fitzinger, 1826, that according to Bauer (2003) is here referred to *Trachylepis* Fitzinger, 1843.

Figure 2. *Tarentola fascicularis* from Great Kuriat.

RESULTS

Species list

Familia GEKKONIDAE

Hemidactylus turcicus Linnaeus, 1758

This species has been detected in both the Kuriat islets. On Great Kuriat it seems widely distributed in the calcareous outcrops which cover almost one third of the island surface, while only one specimen was found on Small Kuriat, near the shacks on the beach that are used by daily visitors in summer.

Familia PHYLLODACTYLIDAE

Tarentola fascicularis (Daudin, 1802)

The identification of this species was done according to the diagnostic characters reported by Joger (1984; see also Joger & Bshaenia, 2010) and was kindly confirmed by the colleague Wadid Tlili on the basis of detailed photos of some of them (Fig. 2). During the present research, it has been found just on Great Kuriat, which results to be the first record for the Tunisian islands (see Tlili et al., 2012). However, *T. fascicularis* certainly inhabits other insular areas, such as Djerba and Kerkennah (W. Tlili, unpubl. data), and its distribution on continental Tunisia needs to be clarified. On Great Kuriat the species seems to be relatively common in the calcareous outcrops, where it is syntopyc with *Hemidactylus turcicus*.

Familia SCINCIDAE

Chalcides ocellatus (Forsskål, 1775)

This species has been found both on Small Kuriat and Jbel. Most of the observations were done in the proximity of the shoreline, where the Ocellated skink use as shelter the dry litter of sea-grass within the halophile scrubs (Fig. 3).

Trachylepis vittata (Olivier, 1804)

This species (Fig. 4) had never been previously reported for the Tunisian islands (see Boulenger, 1891; Escherich, 1896; Mayet, 1903; Lanza & Bruzzone, 1959; Schneider, 1969; Blanc, 1988; Blanc & Nouira, 1988; Schlüter, 2002; Delaugerre et al., 2011). It has been found in all the islets investigated during the present research, including the tiny Jbel, where together with *Chalcides ocellatus* resulted to be the only occurring reptile species. On these islets most part of the observations were done along the coastal belt, in the same habitat occupied by the Ocellated skink (see Fig. 3).

Familia LACERTIDAE

Mesalina olivieri (Audouin, 1829)

This lizard (Fig. 5) has been detected only on Great Kuriat, where it seems relatively common mainly within the salt-marsh plant communities around the sebkhas.

Familia LAMPROPHIIDAE

Malpolon insignitus (Geoffroy Saint-Hilaire, 1827)

During a 6-hours visit to Small Kuriat, we were able to find two individuals belonging to this species; one of them (Fig. 6) had the tail in necrosis, probably after being hit by gulls or rats. Some colleagues who visit regularly the islets have informed us that gray-green snakes, probably belonging to the same species, would be present also on Great Kuriat. Nevertheless, we explored this islet for a whole day and even in the night, and we did not observe any individual.

DISCUSSION

The herpetofauna of the studied islets includes six species of reptiles, namely five lizards and one snake. No amphibians have been found during the present research and, despite the occurrence of sebkhas and few other wet microhabitats (such as the well near the lighthouse on Great Kuriat), the absence of these animals seems likely probable. Species richness increases with the size of the islets and, consequently, appears to be related to their biotic capacity (see Table 1).

The skink *Trachylepis vittata* is the most frequent species and occurs on all the studied islets, although its record represents the first known for the Tunisian islands. Furthermore, the syntopy of *T. vittata* and *Chalcides ocellatus* on the tiny islet of Jbel sounds quite interesting, as they share the same habitat and even overlap in access to the scarce trophic resources available in such small micro-insular environment. During the field work has however not been possible to determine the eventual occurrence of interspecific competition. According to Kalboussi & Nouira (2004a), both skinks are the most abundant lizards in the oases of Southern

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Figure 3. Habitat of *Chalcides ocellatus* and *Trachylepis vittata* at Jbel. Figure 4. *Trachylepis vittata* from Jbel. Figure 5. *Mesalina olivieri* from Great Kuriat. Figure 6. *Malpolon insignitus* from Small Kuriat.

Species	Great Kuriat	Small Kuriat	Jbel
Hemidactylus turcicus	*	*	
Tarentola fascicularis	*		
Trachylepis vittata	*	*	*
Chalcides ocellatus		*	*
Mesalina olivieri	*		
Malpolon insignitus	?	*	

Table 1. Species distribution on the Kuriat and Jbel islands.

Tunisia. It is likely anyway that in continental areas the resource partitioning among these species could be more balanced by their different foraging mode (see also Kalboussi & Nouira, 2004b) and by the wider trophic opportunities.

Also *Tarentola fascicularis* has not been previously recorded in literature for the Tunisian islands, even if unpublished data indicate its occurrence on Djerba and Kerkennah (W. Tlili, pers. comun.); there is also a record for Lampedusa Island, in the Channel of Sicily, that belongs to the African continental shelf (Harris et al., 2009). This taxon has been considered for a long time as subspecies of *T. mauritanica*, and its evolutionary relationships with this latter, as well as its taxonomic status, are still under debate (see Joger & Bshaenia, 2010; Farjallah et al., 2013). The distribution of *T. fascicularis* includes the eastern North Africa and has its north-western boundary in central Tunisia, where it is sympatric with *T. mauritanica* (Tlili et al., 2012). On the basis of current information, this latter seems to be most common in coastal areas, while *T. fascicularis* has been found mainly in the inland ones. In this view, the occurrence of this species on islets such as Kuriat is not easily to be interpreted, and further investigations may clarify if it is effectively absent along the coast of Monastir. On the other hand, *T. mauritanica* is known to have recently expanded its distribution due to the anthropogenic dispersal (Aprea et al., 2011), therefore can not be excluded that the occurrence of *T. fascicularis* on Kuriat could has a relict significance.

The only snake found during our visits was *Malpolon insignitus*, which has been observed on Small Kuriat and whose occurrence is supposed also for Great Kuriat. However, if confirmed by further investigations, the population of this latter islet should be presumably characterized by an extremely low density.

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REFERENCES

Aprea G., Lo Cascio P., Corti C. & Zuffi M.A.L., 2011. *Tarentola mauritanica* (Linnaeus, 1758). In: Corti C., Capula M., Luiselli L., Razzetti E. & Sindaco R. (Eds.). Fauna d'Italia. XLV. Reptilia. Il Sole 24 Ore, Edagricole, Bologna, pp. 280–288.

Bauer A.M., 2003. On the identity of *Lacerta punctata* Linnaeus, 1758, the type species of the genus *Euprepis* Wagler, 1830, and the generic assignment of the Afro-Malagasy skinks. African Journal of Herpetology, 52: 1–7.

Blanc C., 1988. Biogeographie des Reptiles des iles Zembra et Zembretta. Bulletin d'Ecologie, 19: 255-258.

Blanc C. & Nouira S., 1988. Faune herpétologique des iles Kerkennah: inventaire, distribution et zoogéographie. Bulletin d'Ecologie, 19: 259–263.

Boulenger G.A., 1891. Catalogue of Reptiles and Batrachians of Barbary (Morocco, Algeria and Tunisia) based chiefly upon the notes and collections made in 1880-1884 by M. Fernand Lataste. Transactions of the Zoological Society of London, 13: 93–164.

Delaugerre M., Ouni R. & Nouira S., 2011. Is the European Leaf-toed gecko *Euleptes europaea* also an

African? Its occurrence in Western Mediterranean landbridge islets and its extinction rate. Herpetology Notes, 4: 127–137.

Escherich C., 1896. Beitrag zur Fauna der Tunisischen Insel Djerba. Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien, 46: 268–279.

Farjallah S., Amor N., Gharbi R. & Said K., 2013. Relationships of the Moorish Gecko *Tarentola mauritanica* sensu lato (Reptilia, Phyllodactylidae) populations in Tunisia: morphometric and karyological assessment. Annales Zoologici, 63: 149–156.

Harris D.J., Carretero M.A., Corti C. & Lo Cascio P., 2009. Genetic affinities of *Tarentola mauritanica* (Reptilia: Gekkonidae) from Lampedusa and Conigli islet (SW Italy). North-Western Journal of Zoology, 5: 197–205.

Joger U., 1984. Taxonomische Revision der Gattung *Tarentola* (Reptilia: Gekkonidae). Bonner zoologische Beiträge, 35: 129–174.

Joger U. & Bshaenia I., 2010. A new *Tarentola* subspecies (Reptilia: Gekkonidae) endemic to Tunisia. Bonn zoological Bulletin, 57: 267–274.

Jribi I., Bradai M.N. & Bouain A., 2006. Loggerhead turtle nesting activity in Kuriat Islands (Tunisia): assessment of nine years monitoring. Marine Turtle Newsletter, 112: 12–13.

Kalboussi M. & Nouira S., 2004a. Comparative diet of northern and southern Tunisian populations of *Chalcides ocellatus* (Forskal, 1775). Revista Española de Herpetologia, 18: 29–39.

Kalboussi M. & Nouira S., 2004b. Régime alimentaire de *Mabuya vittata* (Olivier, 1804) (Reptilia: Scincidae) en Tunisie. Bulletin de la Société herpétologique de France, 109: 43–50.

Lambeck K. & Purcell A., 2005. Sea-level change in the Mediterranean Sea since the LGM: model predictions for tectonically stable areas. Quaternary Science Reviews, 24: 1968–1988.

Lanza B. & Bruzzone C.L., 1959. Erpetofauna dell' Arcipelago della Galita (Tunisia). Annali del Museo civico di Storia naturale "G. Doria", 71: 41–56.

Mayet V., 1903. Catalogue raisonné des Reptiles et Batraciens de la Tunisie. Exploration Scientifique de la Tunisie: Zoologie, Reptiles et Batraciens. Imprimerie Nationale, Paris, 32 pp.

Oueslati A., 1995. Les Îles de la Tunisie. Paysages et milieu naturels: genèse, évolution et aptitudes à l'aménagement d'après les repères de la géomorphologie, de l'archéologie et de l'occupation humaine récente. Série Géographique n. 10, SERST-CEREST-Université de Tunis, Tunis, 368 pp.

Posner S.D., 1988. Biological diversity and tropical forests in Tunisia. Report prepared for The Washington D.C. and Tunis Offices of the Agency for International Development. At: http://pdf.usaid.gov/pdf_docs/PNABC250.pdf (last access 04/2014).

Scalia G., 1984. Le Kuriate e Pantelleria. Osservazioni onomastico-etimologiche. Bulletin du Cange, Archivum Latinitatis Medii Aevi, 43: 65–110.

Schleich H.H., Kästle W. & Kabisch K., 1996. Amphibians and Reptiles of North Africa. Koeltz Scientific Publisher, Koenigstein, 627 pp.

Schlüter U., 2002. Die Reptilien und Amphibiens der Kerkennah-Inseln. Elaphe, 10: 68–74.

Schneider B., 1969. Zur Herpetofauna der Galita-Archipels. Die Aquarium und Terrararium Zeitschrift, 22: 249–251.

Sindaco R. & Jeremčenko V.K., 2008. The Reptiles of the Western Palaearctic. 1. Annotated checklist and distributional atlas of the turtles, crocodiles, amphisbaenians, and lizards of Europe, North Africa, Middle East and Central Asia. SHI-Belvedere, Latina, 579 pp.

Sindaco R., Venchi A. & Grieco C., 2013. The Reptiles of the Western Palaearctic. 2. Annotated checklist and distributional atlas of the snakes of Europe, North Africa, Middle East and Central Asia, with an update to the Vol. 1. SHI-Belvedere, Latina, 543 pp.

Szczerbak N.N., 1989. Catalogue of the African Sand Lizards (Reptilia: Sauria: Eremiainae: *Lampreremias*, *Pseuderemias*, *Taeniaeremias*, *Mesalina*, *Meroles*). Herpetozoa, 1: 119–132.

Tlili W., Delaugerre M., Ouni R. & Nouira S., 2012. Distributional review of the genus *Tarentola* (Reptilia, Sauria) in Tunisia (North Africa). Herpetology Notes, 5: 485–492.

Biodiversity Journal, 2014, 5 (3): 397–420

The cave crickets of Greece: a contribution to the study of Southern Balkan Rhaphidophoridae diversity (Orthoptera), with the description of a new species of *Troglophilus* Krauss, 1879

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ABSTRACT

The taxonomy, geographic distribution and ecology of Rhaphidophoridae of Greece are updated herein. At present, 28 species of *Dolichopoda* Bolívar, 1880 and five species of *Troglophilus* Krauss, 1879 are known to colonize Greek caves and, in a few circumstances, epigean habitats. *Dolichopoda* includes a high number of species and shows a wide geographic distribution, including most of Greece. The genus diversity peaks in the Hellenic region, which hosts 28 of the 51 species described thus far. Most of the *Dolichopoda* species show a high degree of endemism, being recorded from only one or a few caves in restricted geographic areas. The thermo-xerophilic climate characterizing most of the southern Balkan Peninsula and the high fragmentation of the Greek karstic areas could have played an important role in the reduction of gene flow among cave cricket populations, leading to strong isolation and multiple speciation events. All the *Dolichopoda* species found in the area are highly dependent on caves and show clear adaptations to the subterranean ecosystems. Of the five *Troglophilus* species known for the area, only two occur in continental Greece, with a very scattered geographic distribution including a few mountain localities in northern and central Greece. The remaining three species are widespread throughout Crete and some Aegean islands. Finally the newly discovered *Troglophilus zoiai* n. sp. from a cave on the western slope of Mount Parnassos (central Greece) is described.

KEY WORDS Dolichopodainae; Troglophilinae; cave crickets; Greece.

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INTRODUCTION

In the Mediterranean area the family Rhaphidophoridae is represented by only two genera (*Dolichopoda* Bolívar, 1880 and *Troglophilus* Krauss, 1879) with a fairly overlapping eastern Mediterranean distribution.

Dolichopoda includes 51 described species inhabiting cave habitats from the Pyrenees to the Caspian region in Northern Iran (Di Russo & Rampini, 2014). *Troglophilus* includes only 15 species distributed from the Eastern Alps to the Anatolian Peninsula (Eades et al., 2014). The first species of the family to be reported for Greece was *Troglophilus spinulosus* Chopard, 1921. Chopard (1921) based the description of the species on some specimens collected in the Sendoni Cave, Crete (Chopard, 1921; Boudou-Saltet, 1978). Some years later,

Werner (1927) described a second species of the same genus from Western Crete (*T. roeweri*) while Menozzi (1935) reported *Troglophilus lagoi* Menozzi, 1935 from Rhodes and Chopard (1934) recorded both *Dolichopoda hussoni* and *D. remyi* from Macedonia. After these early studies, a great effort to improve the knowledge of the Greek Rhaphidophoridae was made by Chopard and Boudou-Saltet between 1950 and 1980 (Chopard, 1954, 1955, 1964; Boudou-Saltet, 1970, 1971a, 1971b, 1972a, 1972b, 1973a, 1973b, 1978, 1980, 1983), leading to the description of 16 new species.

The first attempt to summarize the taxonomy and geographic distribution of Greek Rhaphidophoridae was published by Willemse (1984), in which he reported 17 species of *Dolichopoda* distributed from some Ionian islands (Corfu and Petalas) and the Peloponnese to Thrace (Thasos Island) and Crete, including a few localities in central Greece and Attica. Except for Naxos, no other sites were reported for the Aegean area. Willemse (1984) listed six species of *Troglophilus*, three from Crete, one from Rhodes and *T. cavicola* and *T. neglectus* from central Greece and Macedonia respectively. Kollaros et al. (1991), studying many *Troglophilus* specimens from Crete, revised the systematics of the genus and concluded that Crete hosted only one species (*T. spinulosus*). New research on the Rhaphidophoridae cave crickets from Greece starting in 2002 led to the description of several new species, in particular *Troglophilus marinae* Rampini et Di Russo, 2003 from a cave on Santorini Island and eight new species of *Dolichopoda* from Ionian and Aegean islands (Galvagni, 2002; Rampini & Di Russo, 2003a; Rampini et al., 2008, 2012).

The aim of this note is to update the knowledge of the taxonomy and geographic distribution of Greek Rhaphidophoridae species; some ecological information is also presented and discussed.

MATERIAL AND METHODS

All the studied specimens were collected during several field trips starting in 1980. Specimens were preserved in 70% alcohol and deposited in the collection of the Museum of Zoology of the University of Rome "La Sapienza" (MZUR) (Rome, Italy).

Other typical material not examined by us is deposited in the following institutions and collections: BM (NH) = British Museum (Natural History), London; MSNM = Museo Civico di Storia Naturale, Milan; MNHN = Muséum National d'Histoire Naturelle, Paris; PC = Patrizi collection; ZMA = Zoological Museum, Amsterdam.

The specimens were studied with a Leica MZ 12.5 stereomicroscope. All measurements are in mm. For the concise description of the species we considered the following main morphological characters commonly used for taxonomic purposes in both *Dolichopoda* and *Troglophilus*: tergum X, epiphallus, subgenital plate for males and subgenital plate and ovipositor for females. Photographs were taken with a Nikon Coolpix 5000 digital camera. The photographs and distribution map were processed using ACDSee Pro 7.

RESULTS

List of species and taxonomic notes

The species listed here have been ordered following a North-South geographic criterion.

Superfamily RHAPHIDOPHOROIDEA
Family RHAPHIDOPHORIDAE
Subfamily DOLICHOPODAINAE
Genus *Dolichopoda* Bolivar, 1880

Dolichopoda hussoni Chopard, 1934

TYPE LOCALITY. Greek Macedonia, Imathia, Naousa, Megalou Alexandrou cave, 25.VIII.1933, P. Remy and R. Husson leg., 1 male, 2 females (MNHN) (Chopard, 1934).

OTHER LOCALITIES KNOWN. Imathia: Naousa, Paparados cave, altitude 335 m, 25.VIII.1933, P. Remy and R. Husson leg.; same locality, 24.V.1954, K. Lindberg leg.; Naousa, Apano Skala cave near the slaughterhouse, 26.VIII.1933, P. Remy and R. Husson leg.; same locality, 24.V.1954, K. Lindberg leg.; Naousa, Izborjia cave, 25.V.1954, K. Lindberg leg.

EXAMINED MATERIAL. Imathia: Naousa, Paparados cave, altitude 335 m, 04.IV.1990, M. Rampini leg., 1 female; Naousa, Esvoria, "The School of

Aristotle", 09.IV.1993, M. Cobolli leg., 1 male, 1 female; Naousa, Apano Skala cave near the slaughterhouse, 07.VII.1997, M. Rampini leg., 7 males, 1 female; Naousa, Izborjia cave, 10.VII.1997, M. Rampini leg., 1 male (MZUR).

CHARACTERS. Male. Size relatively big ranging between 20–22 mm. Ventral edge of hind femur unarmed. Tergum X with a curved ridge and two small rounded tubercles (Figs. 1, 2). Epiphallus very thin with acute and curved apex (Fig. 3).

Female. Subgenital plate triangular with rounded apex. Ovipositor 17 mm long with 16 denticles on the inner valves.

Dolichopoda remyi Chopard, 1934

TYPE LOCALITY. Greek Macedonia, Imathia, Loutraki, Pozarska mala Pestera, 22.VIII.1933, P. Remy and R. Husson leg., 1 male, 1 female (MNHN) (Chopard, 1934).

OTHER LOCALITIES KNOWN. Pella, Edessa, Boudljeva cave, 23.VIII.1933, P. Remy and R. Husson leg.; same locality, 3.V.1954, K. Lindberg leg.; Imathia, Loutraki, Temma Pestera cave, 21.VIII.1933, P. Remy and R. Husson leg.; Pella, Nissi, Kuradska Pestera cave, 14.VIII.1933, P. Remy and R. Husson leg.; Pella, Agras, Pestera na Bujor cave, 16.VIII.1933, P. Remy and R. Husson leg.

EXAMINED MATERIAL. Imathia, Loutraki, Pozarska mala Pestera, 06.III.1991, M. Rampini leg., 1 male, 1 female; same locality, 07.VII.1997, M. Rampini leg., 2 males, 2 females; Pella, Edessa, small cave below the big waterfall named Karanos, 07.VII.1997, M. Rampini leg., 4 males, 2 females, 6 nymphs, 24.IV.2006, M. Rampini leg., 3 males, 2 females; Imathia, Naousa, Apano Skala cave, under the slaughterhouse, 10.VII.1997, M. Rampini leg., 2 males, 2 females (MZUR).

CHARACTERS. Male. Size relatively big ranging between 20–23 mm. Species characterized by the occurrence of about 20 spines on the ventral edge of the hind femurs. Tergum IX strongly sinous. Tergum X with two pronounced rounded ridges (Figs. 4, 5). Epiphallus long, strength with acute apex (Fig. 6).

Female. Subgenital plate sub-triangular. Ovipositor straight 15 mm long with 18 denticles on the inner valves.

Dolichopoda annae Boudou-Saltet, 1973

TYPE LOCALITY. Thessaly, Larissa, unnamed small cave, date not specified, 1971, A. Petrochilos leg., 2 males, 1 female. Kind of type: unspecified primary type (Boudou-Saltet, 1973a).

EXAMINED MATERIAL. Thessaly: Ampelakia, Tempi Valley, railway tunnel, 25.V.2007, M. Rampini leg., 2 males, 1 female; Agia Paraskevi cave, 25.V.2007, M. Rampini leg., 1 male, 3 nymphs; Kalipefki, Leptokaria, unnamed small cave, 25.V.2007, M. Rampini leg., 2 males, 3 nymphs (MZUR).

CHARACTERS. Male. Size 20 mm. Tergum IX deeply incised in the middle. Tergum X with two folded ridges (Figs. 7, 8). Lobes of the subgenital plate triangular with two short styli. Epiphallus slender very curved with acute apex (Fig. 9).

Female. Subgenital plate triangular, laterally thickened and rounded at the apex. Ovipositor 13.5 mm long, enlarged at the base. The inner valves with 17 denticles.

Dolichopoda thasosensis Chopard, 1964

TYPE LOCALITY. Thrace, Thasos Island, Panaghia, Drakotripa cave, 15.VII.1963, S. Daan and V. van Loar leg., 1 male, 1 female (ZMA) (Chopard, 1964).

CHARACTERS (by Chopard, 1964). Male. Size 21.0 mm. Tergum X with two diverging triangular lobes. Lobes of the subgenital plate with two short styli. Epiphallus strongly curved with a rounded apex.

Female. Subgenital plate triangular lightly incised at the middle, it shows at the base a triangular protuberance. Ovipositor 12 mm long with the inner valves bearing 16 denticles.

Dolichopoda graeca Chopard, 1964

TYPE LOCALITY. Epirus, Ioannina, Perama cave, 23.VIII.1962, G. D'Harvey leg., 1 male, 1 female BM (N.H.) (Chopard, 1964).

EXAMINED MATERIAL. Epirus, Ioannina, Perama cave, 10.IV.1988, M. Rampini leg., 3 nymphs; same locality, 31.V.1989, S. Zoia leg., 1 nymph; same locality, 29.VI.1991, M. Rampini leg., 2 males, 5 nymphs (MZUR).

CHARACTERS. Male. Size 21.5 mm. Tergum X with two evident conical tubercles and trapezoidal lateral lobes (Figs. 10, 11). Subgenital plate with triangular lobes and bearing two cylindrical styli. Epiphallus quite large at the base, cylindrical and rounded at the apex (Fig. 12).

Female. Subgenital plate triangular with a rounded apex slightly incised in the middle. Ovipositor 12 mm long with 15 denticles on the inner valves.

Dolichopoda kiriakii Rampini et Di Russo, 2008

TYPE LOCALITY. Epirus, Preveza, Parga, cave near Agia Kiriaki, altitude 270 m, 24.IV.2006, L. Lustri leg., 3 males, 4 females (MZUR) (Rampini et al., 2008).

CHARACTERS. Male. Size 18–19.5 mm. Tergum X with two evident cylindrical tubercles with rounded apex and two wide lateral lobes (Figs. 13, 14). Epiphallus almost large at the base, long and acute at the apex (Fig. 15). Lobes of the subgenital plate with two short cylindrical styli.

Female. Subgenital plate triangular with thickened lateral edges and a rounded apex. Ovipositor straight, 14 mm long with 18 denticles on the inner valves.

Dolichopoda steriotisi Boudou-Saltet, 1972

TYPE LOCALITY. Ionian Islands, Corfu, Peristerotrypa cave, August 1970, 4 males, 2 females. Kind of type: unspecified primary type (Boudou-Saltet, 1972a).

EXAMINED MATERIAL. Corfu: Klimatia, Antropograva cave, 10.IV.1980, M. Rampini leg., 2 males; same locality, 21.IV.1987, M. Rampini leg., 8 nymphs; same locality, 12.IV.1988, M. Rampini leg., 13 males, 4 females, 2 nymphs; same locality, 12.VIII.2006, C. Di Russo leg., 1 male, 1 female, 1 nymph; Megali cave, near Loutses, 07.IX.1985, F. Gasparo leg., 1 male (MZUR).

CHARACTERS. Male. Size large (23 mm). Tergum X with two small conical tubercles and squared lateral lobes (Figs. 16, 17). Subgenital plate wide with triangular lobes holding short styli. Epihallus slender strongly curved and acute at apex (Fig. 18).

Female. Subgenital plate triangular posteriorly enlarged by an ovoid stripe. Ovipositor 14 mm long with 21 denticles on the inner valves.

Dolichopoda gasparoi Rampini et Di Russo, 2008

TYPE LOCALITY. Ionian Islands, Lefkada, Evghiros, Kirospilia cave, altitude 150 m, 03.IX.2004, F. Gasparo leg., 1 male, 4 nymphs; same locality, 28.V.2006, P.M. Giachino, D. Vailati leg., 1 male, 3 females (MZUR) (Rampini et al., 2008).

CHARACTERS. Male. Size 18.5–19.5 mm. Tergum X with two little evident crests which link the posterior edges of the two large lateral lobes (Figs. 19, 20). Epiphallus lengthened and narrowed towards the base, very arched and acute at the apex (Fig. 21). Lobes of the subgenital plate triangular with two short styli.

Female. Subgenital plate large, triangular with the rounded apex, sides with two protrusion diverging at the base. Ovipositor 13 mm long uniformly curved along its entire length, the inner valves have 16 denticles.

Dolichopoda giachinoi Rampini et Di Russo, 2008

TYPE LOCALITY. Aetolia-Acarnania, Monastiraki (Mount Serekas), Megàlo Spilio cave, altitude 1000 m, 29.V.2006, P.M. Giachino and D. Vailati leg., 1 male, 5 nymphs; same locality, 03.VI.2007, P.M. Giachino and D. Vailati leg., 4 nymphs; same locality, 02.II.2007, M. Rampini leg., 1 male, 1 female, 1 nymph (MZUR) (Rampini et al., 2008).

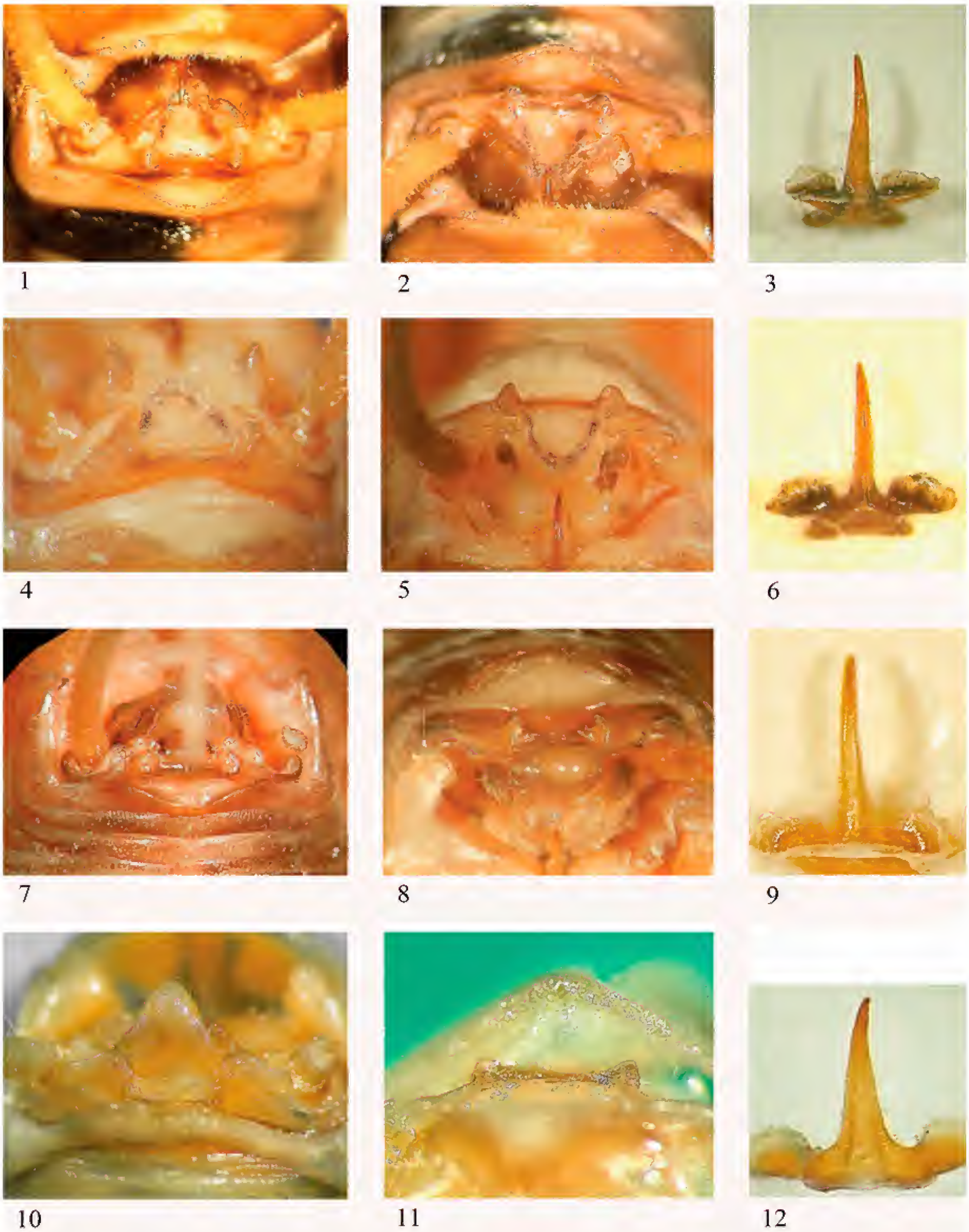
CHARACTERS. Male. Size 18–20 mm. Tergum X with two evident tubercles cone-like connected by a thick crest on the upper margin (Figs. 22, 23). Epiphallus slender and long with an acute apex which curves cephalad (Fig. 24). Lobes of the subgenital plate without styli.

Female. Subgenital plate shaped as a flattened triangle with thickened lateral edges and apex. Ovipositor 15 mm long almost straight, the inner valves with 20 denticles.

Dolichopoda ithakii Rampini et Di Russo, 2008

TYPE LOCALITY. Ionian Islands, Ithaca, near Vathy, Marmarospilia cave, altitude 180 m, 16.VI.2004, F. Gasparo leg., 1 male, 3 nymphs (MZUR) (Rampini et al., 2008).

CHARACTERS. Male. Size 15–16 mm. Tergum X similar to *D. gasparoi* but with the tubercles cone-like and bigger (Figs. 25, 26). Epiphallus slender, curved with a pointed apex (Fig. 27). Lobes of the subgenital plate without styli. Female unknown.



Figures 1–3. *Dolichopoda hussoni*: Fig. 1) tergum X dorsal view, Fig. 2) tergum X posterior view, Fig. 3) epiphallus dorsal view. Figs. 4–6. *D. remyi*: Fig. 4) tergum X dorsal view, Fig. 5) tergum X posterior view, Fig. 6) epiphallus dorsal view. Figs. 7–9. *D. annae*: Fig. 7) tergum X dorsal view, Fig. 8) tergum X posterior view, Fig. 9) epiphallus dorsal view. Figs. 10–12. *D. graeca*: Fig. 10) tergum X dorsal view, Fig. 11) tergum X posterior view, Fig. 12) epiphallus dorsal view.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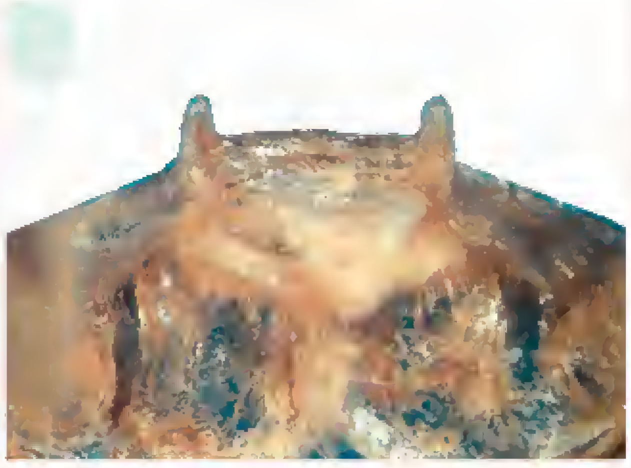
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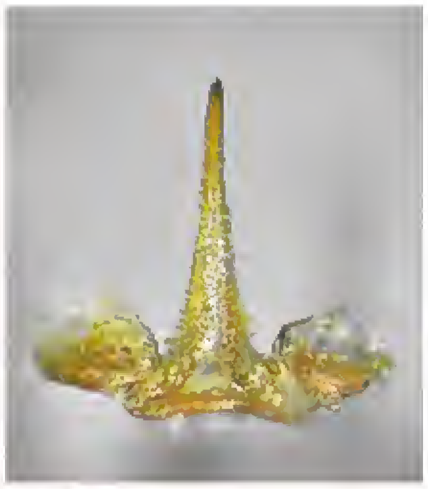
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Figures 13–15. *Dolichopoda kiriakii*: Fig. 13) tergum X dorsal view, Fig. 14) tergum X posterior view, Fig. 15) epiphallus dorsal view. Figs. 16–18. *D. steriotisi*: Fig. 16) tergum X dorsal view, Fig. 17) tergum X posterior view, Fig. 18) epiphallus dorsal view. Figs. 19–21. *D. gasparoi*: Fig. 19) tergum X dorsal view, Fig. 20) tergum X posterior view, Fig. 21) epiphallus dorsal view. Figs. 22–24. *D. giachinoi*: Fig. 22) tergum X dorsal view, Fig. 23) tergum X posterior view, Fig. 24) epiphallus dorsal view.

Dolichopoda pavesii Galvagni, 2002

TYPE LOCALITY. Ionian Islands, Cephalonia, Drakotripa cave, altitude 300 m, cave above the lake Avithos at Agios Nikolaos, XII.1995/V.1996, M. Pavesi leg., 2 males, 12 nymphs (MSNM) (Galvagni, 2002).

EXAMINED MATERIAL. Cephalonia, Sami, Drogarati cave, 13.VIII.2003 C. Di Russo leg., 7 males, 3 females, 2 nymphs; same locality, 15.VI.2004, F. Gasparo leg., 2 males, 4 females, 3 nymphs (MZUR).

CHARACTERS. Male. Size 20–23 mm. Tergum X with two conical tubercles, squared lateral lobes (Figs. 28, 29). Lobes of the subgenital plate with two developed cylindrical styli. Epiphallus enlarged at the base, long, slender, with an acute apex which curves cephalad (Fig. 30).

Female. Subgenital plate triangular, thickened, rounded at apex with a large sclerotized protuberance deeply incised in the middle. Sternite VII has a prominent cone-like protuberance. Ovipositor 12 mm long, basally large but more curved in the first proximal portion, the inner valves with 19 denticles.

Dolichopoda patrizii Chopard, 1964

TYPE LOCALITY. Ionian Islands, Petalas, Akra cave, 17.VII.1956, S. Patrizi and F. Baschieri leg., 1 male, 1 female (PC) (Chopard, 1964).

EXAMINED MATERIAL. Ionian Islands, Petalas, Akra cave, 28.IV.2007, V. Sbordoni leg., 1 male immature (MZUR).

CHARACTERS. Male. Size 19 mm. Tergum X with two elevated and thickened ridges (Figs. 31, 32). Subgenital plate shows a deep median incisures. Epiphallus thin, straight and acute at the apex (Fig. 33).

Female. Subgenital plate triangular rounded at the apex with a very small indented protrusion. Ovipositor slightly curved, 13 mm long with 17 denticles on the inner valves.

Dolichopoda lustriae Rampini et Di Russo, 2008

TYPE LOCALITY. West Greece, Aetolia-Acarnania: Chalkiopouli (Mount Pselovuni), Agios Andreas cave, altitude 1150 m, 09.II.2007, M. Rampini leg., 1 male, 2 females, 1 nymph (MZUR) (Rampini et al., 2008).

EXAMINED MATERIAL. Central Greece: Phocis, Mount Vardousia, cave unnamed, altitude 1110 m, 10.VI.2005, P. M. Giachino and D. Vailati leg., 5 nymphs; Dafni, Athanasios-Diakos, Dafni cave, 20.X.2008, C. Di Russo leg., 1 male (MZUR).

CHARACTERS. Male. Size relatively big (20–23 mm). Species characterized by the occurrence of about 23 spines on the ventral edge of the hind femurs. Tergum X with two tubercles enlarged, cylindrical and diverging, rounded at the apex connected by a thickened upper edge (Fig. 34). Epiphallus elongated cylindrical and very arched forwards with an acute apex which widens at the base (Fig. 35); basal lobes developed, the posterior ones wing-like in shape. Subgenital plate wide and convex with a deep median incision; lateral lobes are triangular with two large cylindrical styli.

Female. Subgenital plate triangular with rounded apex. Ovipositor 19 mm long, uniformly curved upwards and slender at the apex, the inner valves with 20 denticles.

Dolichopoda matsakisi Boudou-Saltet, 1972

TYPE LOCALITY. Peloponnese, Achaia, Kalavrita, Ton Limnon cave, H. Dalens and J. Matsakis leg., date not specified., 2 males, 4 females, 1 nymph. Kind of type: unspecified primary type (Boudou-Saltet, 1972b).

EXAMINED MATERIAL. Peloponnese, Achaia, Kalavrita, Ton Limnon cave 24.VIII.1990, C. Di Russo leg., 2 males, 3 females, 4 nymphs; same locality, 14.VIII.2005, M. Rampini leg., 1 male, 1 female; same locality, 26.IV.07, V. Sbordoni leg., 2 nymphs; Achaia, Pititsa, Analipsi cave, 13.VIII.2005, M. Rampini leg., 2 males, 2 nymphs; same locality, 04.IV.2005, V. Sbordoni leg., 2 nymphs (MZUR).

CHARACTERS. Male. Size 20 mm. Tergum X with two pyramidal tubercles, squared lateral lobes (Fig. 36). Lobes of the subgenital plate triangular with two long styli. Epiphallus slender and curved with acute apex, the lobes of the basal process few developed, and wing-like in shape (Fig. 37).

Female. Subgenital plate small, triangular, thickened at the rounded apex with a light incision in the middle. Ovipositor 15.5 mm long, slender, almost straight, the inner valves with 18 denticles.

Dolichopoda dalensi Boudou-Saltet, 1972

TYPE LOCALITY. Peloponnese, Argolis, Kefalari, Kephalovrissi cave, date not specified, H. Dalens and J. Matsakis leg., 1 female. Kind of type: unspecified primary type (Boudou-Saltet, 1972b).

EXAMINED MATERIAL. Peloponnese, Argolis, Kefalari, Kephalovrissi cave, 18.VIII.2005, M. Rampini and C. Di Russo leg., 2 males, 4 nymphs (MZUR).

CHARACTERS. Male. Size 21–23 mm. Tergum X with two evident tubercles, pyramidal in shape, trapezoidal lateral lobes with sinuous posterior margins (Fig. 38). Lobes of the subgenital plate with two well-developed and pubescent styli. Epiphallus narrow, elongated, curved forwards, lobes of the basal process well developped and wing-like in shape (Fig. 39).

Female. Subgenital plate large, triangular, thickened at the apex with a light incision in the middle. Ovipositor 19 mm long, basally large and curved along its entire length, inner valves with 16 denticles.

Dolichopoda vandeli Boudou-Saltet, 1970

TYPE LOCALITY. Central Greece, Boeotia, Orkomenos, Dionysos, Hermes cave, 09.IV.1969, P. Saltet leg., 4 males, 7 females, 19 nymphs. Kind of type: unspecified primary type (Boudou-Saltet, 1970).

EXAMINED MATERIAL. Central Greece, Boeotia, Orkomenos, Dionysos, Hermes cave, 04.XI.1987, M. Rampini leg., 3 nymphs; same locality, 18.XI.1989, M. Rampini leg., 5 males, 13 nymphs; 05.XI.2005, M. Rampini and G. Allegrucci leg., 1 male, 2 females, 4 nymphs; Boeotia, Orchomenos, Akontio, cave of the Kopais Lake, 19.VI.2004, P. M. Giachino and D. Vailati leg., 5 nymphs; Mount Elikonas, Agia Triada, cave I, 09.X.2008, M. Rampini leg., 2 females; same locality, 21.IV.2013, C. Di Russo leg., 1 male, 1 female (MZUR).

CHARACTERS. Male. Size 24 mm. Tergum IX triangular with the posterior edge rounded covering the tergum X. Tergum X with two diverging very elongated lateral lobes (Fig. 40). It appears flattened and sinuous at the apex. Lobes of the subgenital plate almost triangular with two short styli. Epiphallus slender slightly curved and at the apex barely bifid (Fig. 41).

Female. Subgenital plate trapezoidal and strongly bilobate. Ovipositor 12 mm long, curved at the apex with the inner valves bearing 16 denticles.

Dolichopoda insignis Chopard, 1955

TYPE LOCALITY. Attica, Athens, Mount Imittos, Koutouki cave, altitude 490 m, 18.IV.1954, J. Petrochilos leg., 1 male (MNHN) (Chopard, 1955).

OTHER LOCALITY KNOWN. Attica, Marathona, Pan cave (prehistoric cave), 29.VIII.1971, P. Boudou-Saltet leg. (Boudou Saltet, 1971b).

EXAMINED MATERIAL. Attica, Marathona, Pan cave (prehistoric cave), 15.XI.1989, M. Rampini leg, 2 males (MZUR).

CHARACTERS. Male. Size 17–18 mm. Species characterized by a tergum IX showing a long median process rounded at the apex. Tergum X with two very elongated lateral lobes extended and sinuous at the apex (Fig. 42). Lobes of the subgenital plate triangular with two very small styli. Epiphallus large flattened with a wide bifurcation at the apex (Fig. 43).

Female. Subgenital plate elongated, triangular with the posterior edge strongly bilobate. Ovipositor 14 mm long slender and curved along its entire length, the inner valves with 19 denticles.

Dolichopoda petrochilosi Chopard, 1954

TYPE LOCALITY. Attica, Athens, Mount Parnitha, cave of Pan, 23.XI.1952, K. Lindberg leg., 1 male, 1 female (MNHN) (Chopard, 1954).

OTHER LOCALITIES KNWON. Attica: Athens, Mount Imittos, Koutouki cave, altitude 490 m, 18.IV.1954, K. Lindberg leg.; Athens, Nea Penteli, Daveli cave, altitude 650 m, 17.IV.1954, K. Lindberg leg.; Athens, Mount Rakhi (Northern Imittos) altitude 490 m, 13.IV.1954, K. Lindberg leg. (Chopard, 1955).

EXAMINED MATERIAL. Attica, Athens, Mount Parnitha, cave of Pan, 07.IV.2013, F. Ballarin leg., 1 male; Attica, Nea Penteli, Daveli cave, 09.XII.2005, M. Rampini and A. Roverelli leg., 2 females; same locality, 09.XII.2013, S. Alexiou leg., 3 nymphs (MZUR).

CHARACTERS. Male. Size 17 mm. Tergum IX trapezoidal, wide with the rounded posterior edge covering the tergum X. Tergum X with elongated lateral lobes not diverging and truncated at the apex (Fig. 44). Lobes of the subgenital plate almost trapezoidal with two prominent styli. Epiphallus slender and curved, with acute and bifid apex (Fig. 45).

Female. Subgenital plate rounded, slightly incised in the middle. Ovipositor 12 mm long with 16 denticles on the inner valves.

Dolichopoda makrykapa Boudou-Saltet, 1980

TYPE LOCALITY. Central Greece, Euboea, Makrykapa, Pigi Nyphi cave, date not specified, 1978, T. Skouras leg., 2 males, 4 females, 4 nymphs. Kind of type: unspecified primary type (Boudou-Saltet, 1980).

EXAMINED MATERIAL. Euboea: Lamari, Paralia Chiliadou, cave near Paralia, 22.V.2006, C. Di Russo leg., 3 males, 2 nymphs; Kato Seta, Agia Triada, cave unnamed, 23.V.2006, C. Di Russo leg., 3 males; Tharounia, Kakalitsa, Skoteini cave, 29.III.2013, F. Ballarin leg., 1 male (MZUR).

CHARACTERS. Male. Size 21 mm. Tergum IX trapezoidal wide covering the tergum X. The lateral lobes of the tergum X are elongated and acute at apex (Fig. 46). Lobes of the subgenital plate rounded with two very short rounded styli. Epiphallus triangular, slender apically, apex slightly bifurcated, the basal lobes are developed (Fig. 47).

Female. Subgenital plate wide, globular, triangular in shape, the posterior edge is rounded and deeply incised in the middle. Ovipositor wide at the base, 12.5 mm long, the inner valves with 20 denticles.

Dolichopoda cassagnaui Boudou-Saltet, 1971

TYPE LOCALITY. Central Greece, Euboea, Karystos (Mount Ochi), Agia Triada cave, 30.VII.1970, Boudou-Saltet leg., 9 males, 3 females, 5 nymphs. Kind of type: unspecified primary type (Boudou-Saltet, 1971a).

EXAMINED MATERIAL. Central Greece, Euboea, Karystos (Mount Ochi), Agia Triada cave, 16.XI.1989, M. Rampini leg., 1 female; same locality, 08.XII.2005, M. Rampini, A. Roverelli leg., 3 males, 4 females (MZUR).

CHARACTERS. Male. Size 21.5 mm. Tergum X with lateral lobes elongated, wide at the base and acute at the apex (Fig. 48). Lobes of the subgenital plate rounded with styli elongated. Epiphallus short, massif, with a typical X-shape, the apex is strongly bifurcated and curved forward, the basal lobes are very reduced (Fig. 49).

Female. Subgenital plate rounded and slightly incised in the middle. Ovipositor 11.5 mm long, the inner valves with 19 denticles.

Dolichopoda ochtoniai Boudou-Saltet, 1983 (nomen nudum)

LOCALITY. Central Greece, Euboea, Ochtonia, cave, date and collector not specified (Boudou-Saltet, 1983).

REMARKS. For this taxon the formal morphological description is not available, therefore we consider here only its nomen nudum.

Dolichopoda saraolakosi Boudou-Saltet, 1983 (nomen nudum)

LOCALITY. North Sporades Islands, Skyros, cave, date and collector not specified (Boudou-Saltet, 1983).

REMARKS. For this taxon the formal morphological description is not available, therefore we consider here only its nomen nudum.

Dolichopoda unicolor Chopard, 1964

TYPE LOCALITY. Peloponnese, Laconia: Selinitza, Katafigi cave, 29.VII.1956, S. Patrizi and F. Baschieri Salvatori leg., 1 male, 1 female (PC) (Chopard, 1964).

EXAMINED MATERIAL. Peloponnese: Laconia, Agios Dimitros, Katafigi cave, 28.III.2005, V. Sbordoni leg., 1 male, 1 female; Mount Taigetos, EOS Shelter, small cave, 18.V.1989, S. Zoia leg., 1 female, 6 nymphs; same locality, 10.IX.1995, L.

Dell'Anna leg., 2 nymphs; Kafiona, Megalo Spilio, 09.IX.1995, L. Dell'Anna leg., 3 males, 2 females; Dirou, Dirou cave, 29.III.2005, V. Sbordoni leg., 1 male, 1 female; same locality, 15.VIII.2005, M. Rampini leg., 4 nymphs; Tripa, Kaiadas cave, 21.III.2013, F. Ballarin leg., 1 male, 2 females, 2 nymphs (MZUR).

CHARACTERS. Male. Size 16 mm. Tergum X without tubercles and the rounded lateral lobes strongly protruding (Fig. 50). Subgenital plate strongly incised in the middle; the lateral lobes are rounded with convex margins and short styli. Epiphallus wide, flattened and little acute at apex, basal process poorly developed (Fig. 51).

Female. Subgenital plate rounded little indented in the middle. Ovipositor slightly curved, 12 mm long with 17 denticles on the inner valves.

Dolichopoda naxia Boudou-Saltet, 1972

TYPE LOCALITY. Cyclades Islands, Naxos, Filotas, Zeus cave, september 1971, Boudou-Saltet leg., 2 males, 1 females, 2 nymphs. Kind of type: unspecified primary type (Boudou-Saltet, 1972a).

EXAMINED MATERIAL. Cyclades Islands, Naxos, Filotas, Zeus cave, 08.IV.2007, V. Sbordoni leg., 2 males (MZUR).

CHARACTERS. Male. Size relatively large (19 mm). Tergum X without tubercles and two short lobes (Fig. 52). Subgenital plate wide with rounded lateral lobes holding two evident styli. Epiphallus moderately flattened, slightly curved and with rounded apex, basal process poorly developed (Fig. 53).

Female. Subgenital plate wide posteriorly rounded and moderately incised in the middle. Ovipositor 11.5 mm long, slender and elongated, the inner valves have 16 denticles.

Dolichopoda calidnae Rampini et Di Russo, 2012

TYPE LOCALITY. Southern Aegean Islands, Kalymnos, Pothia, Seven Virgins cave, 28.III.2004, M. Rampini and C. Di Russo leg., 2 males, 5 females; Skalia, unnamed cave near Skalia (Mount Flaska), 28.III.2004, M. Rampini and C. Di Russo leg., 3 males, 5 nymphs (MZUR) (Rampini et al., 2012).

CHARACTERS. Male. Size 17.5 mm. Tergum X shows on the posterior edge two large lateral lobes, triangular in shape, with rather rounded apex (Fig. 54). Subgenital plate globular at the bottom, with a deep middle incision that runs for half of the total length. Lateral lobes trapezoidal, with two short conical styli. The epiphallus is sclerotized and shows a median process relatively long, lightly flattened and acute apically. In lateral view, it appears large at the base and uniformly curved; the basal processes poorly developed are squared and slightly divergent (Fig. 55).

Female. Subgenital plate triangular with two moderately incised lobes in the middle. The ovipositor has an average length of 11 mm, it is enlarged at the base and regularly curved on the superior edge, the inferior valves have 15 denticles.

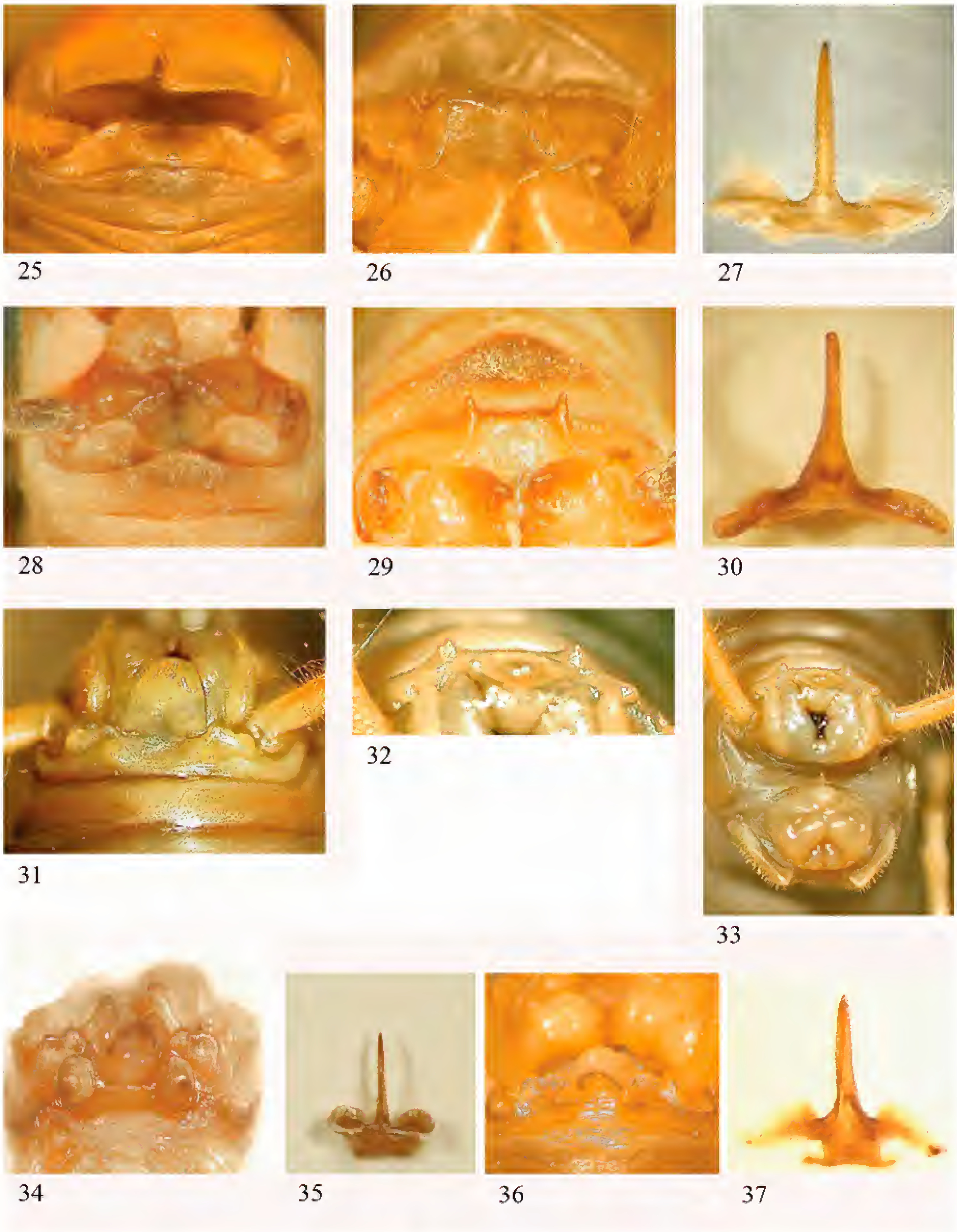
Dolichopoda kalithea Di Russo et Rampini, 2012

TYPE LOCALITY. North Aegean Islands, Samos, Mount Kerkis, Kakoperato canyon, altitude 660 m, Kakoperato cave, 05.IV.2008, C. Di Russo and M. Rampini leg., 7 males, 1 female, 2 nymphs (MZUR) (Rampini et al., 2012).

EXAMINED MATERIAL. Marathokambos, Votsalakia, Sarantaskaliotissa cave altitude 320 m, (near Pythagoras cave), South-Eastern slopes of Mount Kerkis, 05.IV.2008, C. Di Russo and M. Rampini leg., 1 male, 2 females, 3 nymphs (MZUR).

CHARACTERS. Male. Size 16.5 mm. Tergum X has two triangular lobes quite developed and separated by a large concavity (Fig. 56). The subgenital plate shows two trapezoidal lobes, straight on the posterior edges and separated by a relatively short incision; the lobes hold two prominent cylindrical styli. The epiphallus is sclerotized and shows a quite flattened median process with an enlarged base, basal process poorly developed; laterally, it appears rather thick at the base and strongly arched distally (Fig. 57).

Female. Subgenital plate rounded and slightly incised in the middle. The ovipositor has an average length of 12.0 mm, rather enlarged at the base and regularly curved on the superior edge. The superior valves have a pointed apex and curves upwards, the inferior valves have 14 denticles.



Figures 25–27. *Dolichopoda ithakii*: Fig. 25) tergum X dorsal view, Fig. 26) tergum X posterior view, Fig. 27) epiphallus dorsal view. Figs. 28–30. *D. pavesii*: Fig. 28) tergum X dorsal view, Fig. 29) tergum X posterior view, Fig. 30) epiphallus dorsal view. Figs. 31–33. *D. patrizii*: Fig. 31) tergum X dorsal view, Fig. 32) tergum X posterior view, Fig. 33) juvenile genitalia. Figs. 34, 35. *D. lustriae*: Fig. 34) tergum X dorsal view, Fig. 35) epiphallus dorsal view. Figs. 36, 37. *D. matsakisi*: Fig. 36) tergum X dorsal view, Fig. 37) epiphallus dorsal view.

Figures 38, 39. *Dolichopoda dalensi*: Fig. 38) tergum X dorsal view, Fig. 39) epiphallus dorsal view. Figs. 40, 41. *D. vandeli*: Fig. 40) tergum X dorsal view, Fig. 41) epiphallus dorsal view. Figs. 42, 43. *D. insignis*: Fig. 42) tergum X dorsal view, Fig. 43) epiphallus dorsal view. Figs. 44, 45. *D. petrochilosi*: Fig. 44) tergum X dorsal view, Fig. 45) epiphallus dorsal view. Figs. 46, 47. *D. makrykapa*: Fig. 46) tergum X dorsal view, Fig. 47) epiphallus dorsal view. Figs. 48, 49. *D. cassagnaui*: Fig. 48) tergum X dorsal view, Fig. 49) epiphallus dorsal view. Figs. 50, 51. *D. unicolor*: Fig. 50) tergum X dorsal view, Fig. 51) epiphallus dorsal view. Figs. 52, 53. *D. naxia*: Fig. 52) tergum X dorsal view, Fig. 53) epiphallus dorsal view.

Dolichopoda giulianae Rampini et Di Russo, 2012

TYPE LOCALITY. North Aegean Islands, Samos, Pythagorion, Panagia Spiliani cave, 21.VIII.2002, F. Gasparo leg., 1 female, 5 nymphs; same locality, 04.IV.2008, M. Rampini and C. Di Russo leg., 5 males, 2 females, 3 nymphs (MZUR) (Rampini et al., 2012).

CHARACTERS. Male. Size 14.5 mm. Tergum X shows two prominent lobes on the posterior edge, almost squared at the apex (Fig. 58). The subgenital plate, globular at the bottom, shows two triangular lateral lobes, holding two short conical styli. The epiphallus is sclerotized and shows a long flattened median process, acute at the apex, basal process poorly developed; from the side, it appears uniformly curved (Fig. 59).

Female. Subgenital plate trapezoidal with two rounded lobes. The ovipositor has an average length of 11.0 mm, and 15 denticles on the inner valves.

Dolichopoda paraskevii Boudou-Saltet, 1973

TYPE LOCALITY. Crete, Heraklion, Skotino, Agia Paraskevi cave, september 1971, Boudou-Saltet leg., 1 male, 2 females, 12 nymphs. Kind of type: unspecified primary type (Boudou-Saltet, 1973b).

EXAMINED MATERIAL. Crete, Heraklion, Skotinon, Agia Paraskevi cave, 09.VII.1995, M. Rampini leg., 2 males, 7 females, 6 nymphs; same locality, 04.VI.2002, F. Gasparo leg., 3 nymphs; Lasithi, Milatos, Milatos cave, 09.VII.1995, M. Rampini leg., 6 nymphs; Lassithi, Adrianos, Atziganospilios cave, 14.VII.1995, C. Di Russo leg., 1 nymph; same locality, 18.X.1997, M. Rampini leg., 2 males, 1 female, 10 nymphs (MZUR).

CHARACTERS. Male. Size 14.5 mm. Tergum X with triangular lobes rounded at the apex (Fig. 60). Subgenital plate wide with rounded margins and two short styli. The epiphallus is sclerotized and shows a broad and flattened median process, laterally it appears few curved; the basal processes are few developed (Fig. 61).

Female. Subgenital plate wide and bilobate. Ovipositor 11–12 mm long, light curved with 13 denticles on the inner valves.

Dolichopoda sp.

In this section we report the list of the localities where immature specimens were collected and deposited in the MZUR collection.

Epirus: Arta-Athamania, Mount Athamano, Athamanio, altitude 1000 m (epigean), 29.V.2005, P. M. Giachino, D. Vailati leg.

Aetolia-Acarnania: Nafpaktos, Rigani (3 Km before), unnamed cave, 31.V.2005, P.M. Giachino and D. Vailati leg.

Thessaly: Magnesia, Orkomenos, Megali spilia, 22.V.1989, S. Zoia leg.; Mount Ossa, Larissa, Kokkinovramo cave, 25.V.1989, S. Zoia leg.; Karditsa, Belokomiti, Gaki cave, 12.VI.2008 and 01.VI.2011, P.M. Giachino and D. Vailati leg.

Phocis: Delfi, Mount Parnassos, Korycian Andron cave, altitude 1400 m, 30.IV.2007, V. Sbordoni leg.; Ano Polydrossos, Kontylo cave, altitude 700 m, 09.XII.2013, C. Di Russo and L. Latella leg.; Amfissa, Prosilio, Agios Athanasios cave, altitude 1160 m 21.V.2014, C. Di Russo and M. Rampini leg.

Euboea: Steni Dirfios, Mount Touria, unnamed cave, 05.VI.2010, P.M. Giachino and D. Vailati leg.

Peloponnese: Korinthia, Mount Killini, Hermu cave, 28.IV.1984, M. Zapparoli leg.; Likouria, unnamed cave, 06.VI.2008, P. M. Giachino and D. Vailati leg.; Arcadia, Vitina, Drakotripa, 16.V.1989, S. Zoia leg.; Laconia, Areopoli, Limeni, 08.09.1985, L. Dell'Anna and S. Zoia leg.; Mount Taygetos, Varvara cave, 02.VI.2005, P.M. Giachino and D. Vailati leg.

Subfamily TROGLOPHILINAE
Genus *Troglophilus* Krauss, 1879

Troglophilus (*Paratroglophilus*) *neglectus* Krauss, 1879

TYPE LOCALITY. Istria, (date, collector and exact locality not specified) (Krauss, 1879). This species, widespread from Southern Austria and North-eastern Italy to Southern Balkan, was reported also for a cave near Naousa in Greek Macedonia (Maran, 1958).

CHARACTERS. Male. Size 15–19 mm. Fore, mid femurs and mid tibia lack of spines. Tergum X characterized by two protruding triangular lobes (Fig. 62). Copulatory organ membranous, triangular in

shape. First article of the metatarsus with 8 spines on the upper margin (Fig. 63).

Female. Subgenital plate short trapezoidal with a straight posterior margin (Fig. 64). Ovipositor 8–9 mm long with acute apex. The inner valves have 12 denticles (Fig. 65).

Troglophilus (*Troglophilus*) *cavicola* (Kollar, 1833)

Locusta cavicola Kollar, 1833
Troglophilus cavicola Karny, 1907

TYPE LOCALITY. Austria, Baden, Schelmenloch cave. This species, widespread from Southern Austria and Northeastern Italy to Southern Balkan, is reported for Greece by Brunner von Wattenwyl (1888) from an unnamed cave on Mount Parnassos and by Chopard (1932) from Mount Oiti near Ypati (Willemse, 1984).

CHARACTERS. Male. Size 15–20 mm. The fore and mid femurs lack of spines. Species characterized by tergum X showing two expanded lobes rounded at apex and separated by a deep incision (Fig. 67). Epiphallus evident rather sclerified has a tipical Y-shape, long and slender, arched, and acute at the apex. First article of the metatarsus with 11 spines on the upper margin (Fig. 68).

Female. Subgenital plate large trapezoidal with the posterior edge moderately incised (Fig. 69). Ovipositor elongated and narrow, 9–10 mm long, rounded at the apex. The inner valves with 16 denticles (Fig. 70).

Troglophilus (*Troglophilus*) *zoiai* n. sp.

EXAMINED MATERIAL. Holotype female: Boeotia, Aràchova (Mount Parnassos), Dragon cave, altitude 1813 m, 23.VI.1989, S. Zoia leg.; paratypes: same locality and date, 2 females. Same locality, 22.V.2014, C. Di Russo and M. Rampini leg., 2 females. Other locality: Phocis, Mount Vardousia, Kokkinias, forest on the northern slope at 1390 m, 08.VI.2006, P. M. Giachino and D. Vailati leg., 1 female and several nymphs (MZUR).

DESCRIPTION OF HOLOTYPUS. Size relatively small; colour brown, with all the tergites finely spotted. Tergum X almost narrow, transverse, slightly concave in the middle (Fig. 72). Legs rather elongate, fore and mid femora unarmed. Hind femora with 0/1 short spines on the ventral margin. Fore tibia with 8/10 spines on both sides of the ventral margin. Mid tibia with 10 spines on both sides of the ventral surface and 1/3 short spines on the dorsal surface. The hind tibia is longer with 69/75 spines of varying lengths on both sides of the dorsal surface and 26/35 homogeneous spines on the ventral margin. First article of hind tarsus laterally compressed and armed with 9/11 strong spines (Fig. 73). The subgenital plate is large quite squared with a complete concave posterior margin (Fig. 74). The ovipositor is relatively short resulting almost entirely enlarged from the base to the pointed apex; at the bottom the lower edge appears strongly curved. The inferior valves are narrow and sclerotized showing 11–12 strong denticles (Fig. 75). Measurements (in mm): body 14.6; pronotum 4.0; fore femur 9; middle femur 8; hind femur 15; fore tibia 10; middle tibia 9.0, hind tibia 18.0; hind tarsus 6.3; 1st article of hind tarsus 3.2; ovipositor 10.

ETYMOLOGY. The new species is dedicated to our friend and colleague Stefano Zoia who collected the first specimens in 1989.

BIOLOGY AND DISTRIBUTION. Troglophile species inhabiting both natural caves and mountain epigean habitats. The species is limited to a restricted area of central Greece (Mount Parnassos and Mount Vardousia).

Type locality: Dragon cave is located close to the chapel of the Mountain Refuge in the Parnassos Ski Centre, (Aràchova). The cave is at a height of 1813 m a.s.l. on the western slope of the Mount Parnassos.

COMPARATIVE NOTES. *Troglophilus zoiai* n. sp. differs from the other two Balkan species *T. cavicola* and *T. neglectus* by the large quite squared subgenital plate with a complete concave posterior margin. The ovipositor has a typical shape almost entirely enlarged from the base to the apex. For these two characters *T. zoiai* shows a certain affinity with the South Anatolian species *T. ozeli* Taylan, Di Russo, Cobolli et Rampini, 2012 and *T. bicakcii* Rampini et Di Russo, 2003 (Rampini & Di Russo, 2003b). The new species differs from the Aegean species for the lacking of spines on the femurs.

Troglophilus (*Troglophilus*) *marinae* Rampini et Di Russo, 2003

TYPE LOCALITY. Cyclades Islands, Santorini, Kamari, Zoodochos cave, 27.V.2000, M. Rampini, C. Di Russo leg., 3 males, 7 females. Same locality, 10.IX.1988, M. Cobolli leg., 7 nymphs; 23.X.1999, M. Cobolli leg., 2 males, 3 females, 1 nymph; 06.IX.1999, M. Rampini leg., 1 male, 1 female, 5 nymphs; same locality, 02.X.1999, M. Rampini leg., 1 female (MZUR) (Rampini & Di Russo, 2003a).

CHARACTERS. Male. Size 24 mm. Fore and mid femurs with a series of short spines. Tergum X little depressed medially, lateral lobes short and slightly rounded, posterior margin slightly concave in the middle (Fig. 76). Copulatory organ symmetrical membranous similar to *T. spinulosus*. Subgenital plate wide and trapezoidal in shape with short sub cylindrical styli. First article of the metatarsus with 5 spines on the upper margin (Fig. 77).

Female. Subgenital plate wide at the base, triangular and slightly incised at the apex (Fig. 78). Ovipositor wide and short, 10 mm long acute at the apex. The inner valves with 9 denticles (Fig. 79).

Troglophilus (*Troglophilus*) *lagoi* Menozzi, 1935

TYPE LOCALITY. Southern Aegean, Rhodes, Afando, Paradiso cave, 1934, C. Menozzi leg., 1 male, 1 female. Kind of type: unspecified primary type (Menozzi, 1935).

OTHER LOCALITIES KNOWN. Rhodes, Mount Profeta Elia (altitude 802 m) and Mount Attairo (altitude 1000 m), 1934, C. Menozzi leg. (Menozzi, 1935).

EXAMINED MATERIAL. Rhodes, Rodini Park, Tolomeo Tomb, 23.V.1994, M. Rampini leg., 5 males, 11 females; same locality, 15.VIII.1994, Rampini, C. Tedeschi leg., 1 male, 2 females, 1 nymph; 10.IV.1995, M. Rampini leg., 2 males, 1 female; 07.VII.1996, M. Rampini leg., 1 male, 1 female; 28.VIII.2002, C. Di Russo leg., 3 females, 1 nymph (MZUR).

CHARACTERS. Male. Size 15–16 mm. Hind femur without ventral spines. Tergum X with reduced lateral lobes separated by a slight concavity, medially presents a short triangular plate (Fig. 80). Copulatory organ membranous similar to that of *T. neglectus*. Subgenital plate wide and truncated at the apex with evident sub cylindrical styli. First article of the metatarsus with 8 spines on the upper margin (Fig. 81). Female. Size 18–19 mm. Subgenital plate triangular rounded apically (Fig. 82). Ovipositor short and wide, 8 mm long. The inner valves with 8 denticles (Fig. 83).

Troglophilus (*Troglophilus*) *spinulosus* Chopard, 1921

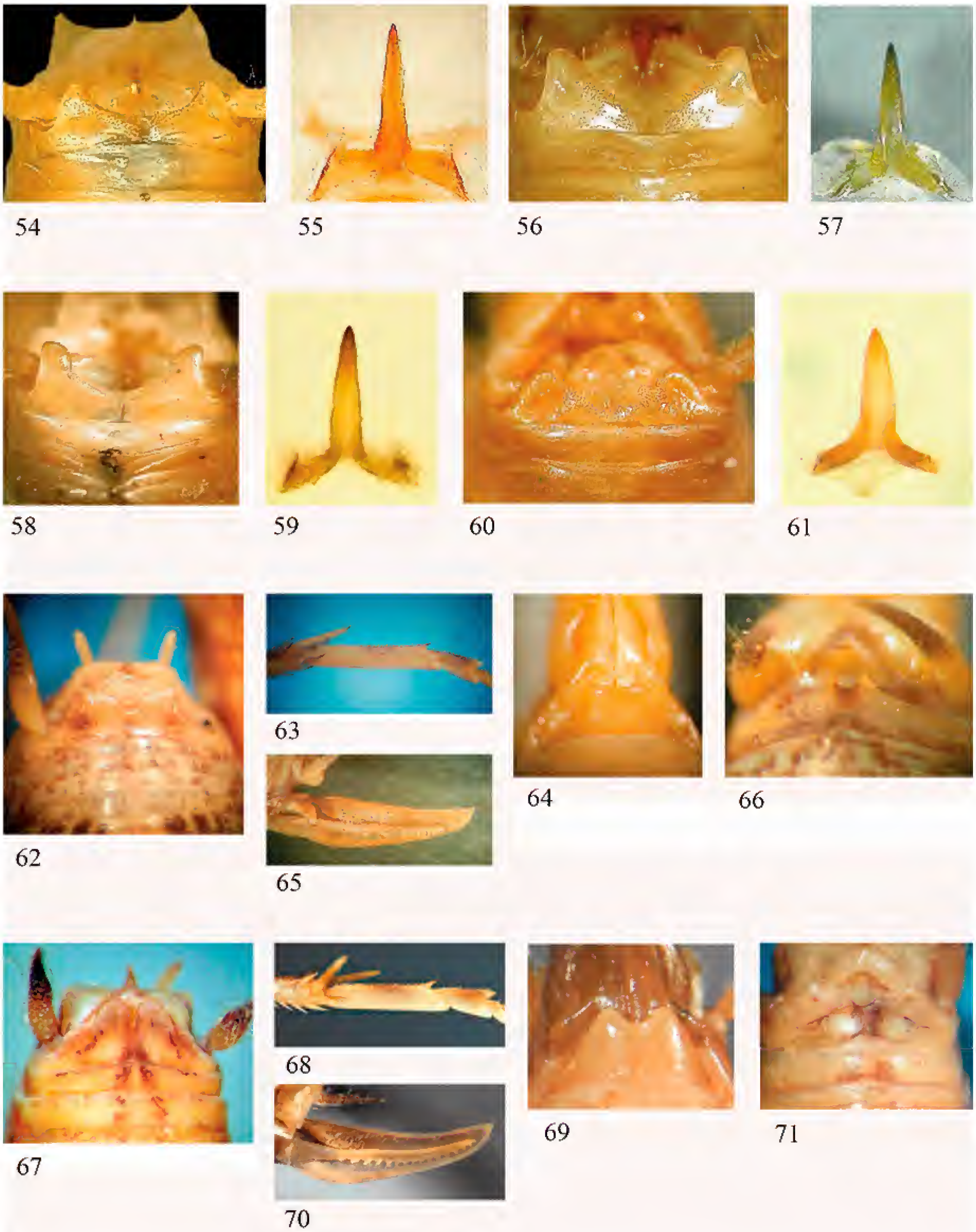
TYPE LOCALITY. Crete, Gonia, unnamed cave, 23.III.1904, D.M.A. Bate leg., 1 male immature BM(NH) (Chopard, 1921).

OTHER LOCALITIES KNOWN. Crete: Dicteon Andron, 07.V.1955, K Lindberg leg.; Katholiko cave, 21.IV.1955, K Lindberg leg.; Achyrospilio cave, 21.IV.1955, K Lindberg leg.

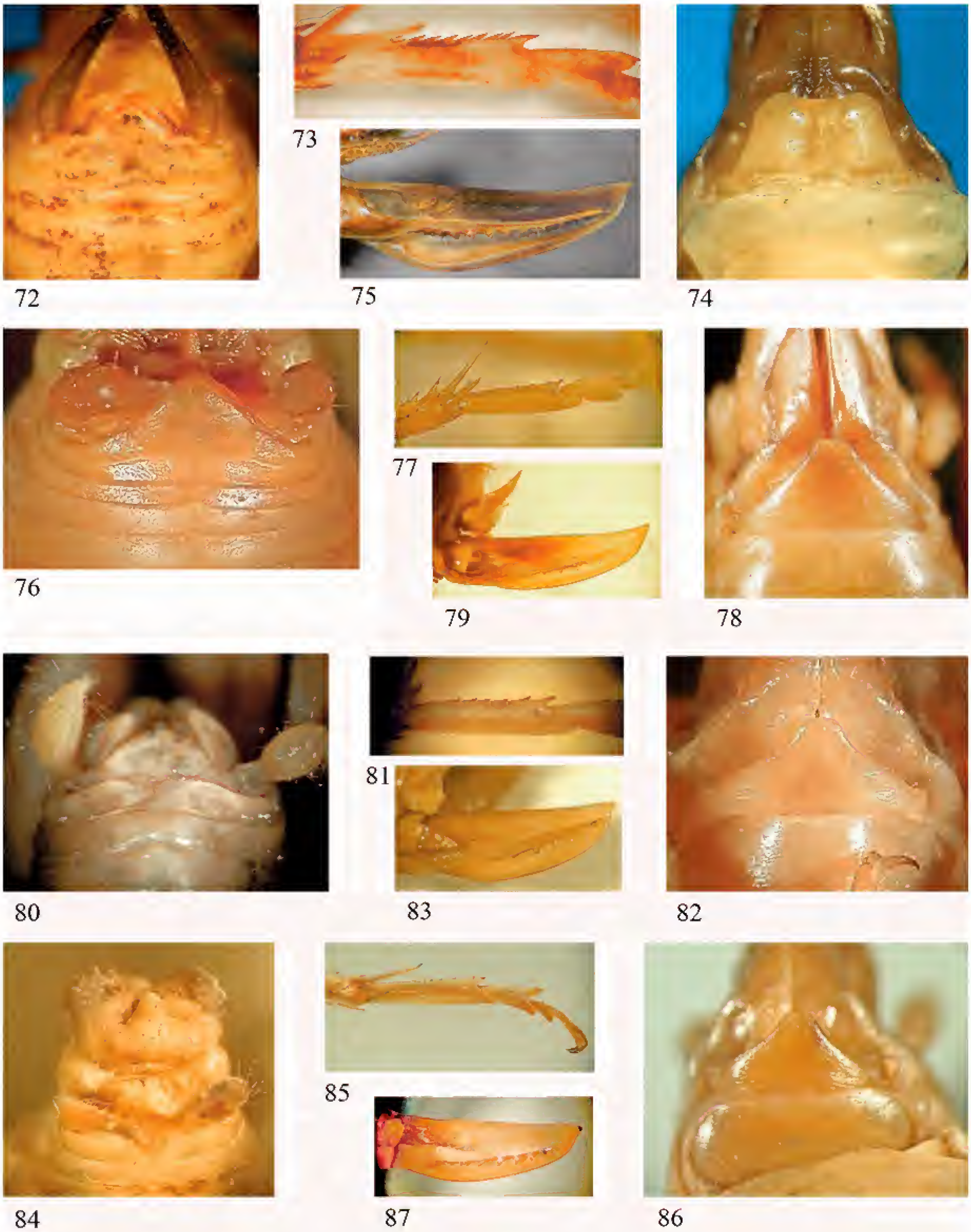
EXAMINED MATERIAL. Crete: Heraklion, Kamaraki, Marmarospilia, altitude 560 m, 31.III.1989, V. Sbordoni leg., 1 female; Heraklion, Marathos, Doxa cave, 01.V.1994, M. Rampini leg., 1 male, 1 female; same locality, 08.VII.1995, M. Rampini leg., 1 male, 2 females; Chania (Akrotiri peninsula), Moni Gouvernetou cave, 20.X.1997, M. Rampini leg., 1 female; Chania, Katholiko cave, 7.VII.1995, M. Rampini leg., 1 female; Lasithi, Milatos, Milatos cave, 08.VII.1995, C. Di Russo leg., 2 nymphs; Omalos, Lakki, unnamed cave, 07.VII.1995, C. Di Russo leg., 1 male; Sitia, Micro Katafigi, 8.VII.1995, M. Rampini leg., 1 female; Adrianos, Zena, Atziganospilios cave, 25.IX.2005, F. Gasparo leg., 1 female (MZUR).

CHARACTERS. Male. Size 20–21 mm. Fore and mid femurs with a series of short spines. Tergum X slightly concave in the middle with two small lateral lobes (Fig. 84). Subgenital plate trapezoidal with an indented posterior margin. Styli conical and elongated. Copulatory organ symmetrical membranous. First article of the metatarsus with 7 spines on the upper margin (Fig. 85).

Female. Subgenital plate wide at the base, triangular and slightly bilobated (Fig. 86). Ovipositor 12.5 mm long acute at the apex. The inner valves have 8 denticles (Fig. 87).



Figures 54, 55. *Dolichopoda calidnae*: Fig. 54) tergum X dorsal view, Fig. 55) epiphallus dorsal view. Figs. 56, 57. *D. kalithea*: Fig. 56) tergum X dorsal view, Fig. 57) epiphallus dorsal view. Figs. 58, 59. *D. giulianae*: Fig. 58) tergum X dorsal view, Fig. 59) epiphallus dorsal view. Figs. 60, 61. *D. paraskevii*: Fig. 60) tergum X dorsal view, Fig. 61) epiphallus dorsal view. Figs. 62–66. *Troglophilus* (*P.*) *neglectus*: 62) male tergum X dorsal view, 63) male 1st article of hind tarsus, 64) female subgenital plate, 65) ovipositor with inner valve, 66) female tergum X dorsal view. Figs. 67–71. *T.* (*T.*) *cavicola*: 67) male tergum X dorsal view, 68) male 1st article of hind tarsus, 69) female subgenital plate, 70) ovipositor with inner valve, 71) female tergum X dorsal view.



Figures 72–75. *Troglophilus* (*T.*) *zoiai* n. sp.: Fig. 72) male tergum X dorsal view, Fig. 73) male 1st article of hind tarsus, Fig. 74) female subgenital plate, 75) ovipositor with inner valve. Figs. 76–79. *T.* (*T.*) *marinae*: Fig. 76) male tergum X dorsal view, Fig. 77) male 1st article of hind tarsus, Fig. 78) female subgenital plate, Fig. 79) ovipositor with inner valve. Figs. 80–83. *T.* (*T.*) *lagoi*: Fig. 80) male tergum X dorsal view, 81) male 1st article of hind tarsus, 82) female subgenital plate, 83) ovipositor with inner valve. Figures 84–87. *T.* (*T.*) *spinulosus*: Fig. 84) female tergum X dorsal view, Fig. 85) female 1st article of hind tarsus, Fig. 86) female subgenital plate, Fig. 87) ovipositor with inner valve.

Troglophilus sp.

In this section we report the list of the localities where immature specimens were collected and deposited in the MZUR collection.

Boeotia: Mount Elikon, Elikonas, altitude 990 m a.s.l., 09.VI.2005, P. M. Giachino, D. Vailati leg.

Phocis: Stromi, Mayer's cave, altitude 1352 m a.s.l., 07.XII.2013, C. Di Russo leg., same locality, 22.V.2014, C. Di Russo leg.; Amfissa, Prosilio, Agios Athanasios cave, altitude 1160 m a.s.l., 21.V.2014, C. Di Russo, M. Rampini leg.

Southern Sporades: Tilos, 27.III.1989, R. Argano, A. Vigna leg.; Kos, Paleo Pyli, cave IV, 25.III.1989, V. Sbordoni leg.

Eastern Macedonia: Drama, Mount Falakron, altitude 1765 m a.s.l., N 41° 18'- E 25° 05', 20.X/7.XI. 1992, P. Wolf leg.

In the appendix the key of the Rhaphidophoridae species known for the Greece is reported.

DISCUSSION

At present, 28 species ascribed to the genus *Dolichopoda* and five to the genus *Troglophilus* are known for Greece (Table 1). *Dolichopoda* has a wide geographic distribution, encompassing most of Greece, with a large number of species (Fig. 88). The diversity of the genus in terms of number of species reaches its peak in the Hellenic region, where about 50% of the described species (28 of 51) are found. This supports the hypothesis that the ancient Aegean plate was a primary area of dispersal for the genus (Ruffo, 1955).

In Greece, *Dolichopoda* has been classically divided on morphological grounds into three subgenera: *Dolichopoda*, *Petrochilosina* Boudou-Saltet, 1980 and *Chopardina* Uvarov, 1921. Nevertheless the morphological grounds for the distinction of *Chopardina* as a distinct subgenus (presence of spinulation on the ventral side of the hind femur) are considered rather weak and of low taxonomic value. In fact, members of this subgenus show a disjointed geographic distribution with another four species in the Italian Peninsula, Sardinia and Corsica (Casale et al., 2005). Furthermore, as outlined by Sbordoni et al. (2005), *Chopardina* is a polyphyletic grouping; the presence of spines on the hind femur could be strongly influenced by environmental factors and their absence represents an adaptation to cave life. Therefore, as discussed by us for the Italian species (Rampini & Di Russo, 2012), the division of *Dolichopoda* into subgenera can be abandoned and only the existence (when possible) of species groupings sharing some morphological characters should be considered.

The geographic distribution of *Dolichopoda* in Greece includes localities in the northwest (Epirus), several Ionian islands, central Greece, Attica, the Peloponnese, Macedonia, Thrace, Crete and some Aegean islands. On the basis of this distribution and the main morphological characters used in this study, we can tentatively recognize the following groupings (Fig. 88):

1. Northeastern species characterized by curved ridges on tergum X (Figs. 2, 5, 8);
2. Ionian species mostly characterized by tergum X with two pronounced tubercles (Figs. 11, 14, 17, 20, 23, 26, 29, 32);
3. Central Greece-Northern Peloponnese species characterized by pyramidal tubercles on tergum X and the basal lobes of the epiphallus wing-shaped (Figs. 35, 37, 39);
4. Attica species characterized by a bifurcate epiphallus (Figs. 41, 43, 45, 47, 49);
5. Southern Peloponnese-Aegean species with basal process of the epiphallus poorly developed and median process quite broad and flattened (Figs. 51, 53, 55, 57, 59, 61). *D. thasosensis*, endemic to Thasos Island (Thrace), does not fall into any of the above groups, showing a very peculiar shape of tergum X.

A similar grouping was proposed by Allegrucci et al. (2009), who used sequencing of mitochondrial genes to infer phylogenetic relationships among Greek *Dolichopoda* species.

The altitudinal distribution of *Dolichopoda* species in Greece ranges from sea level to 1400 m a.s.l. for the Korician Andron Cave (Mount Parnassos). Most of the Greek species are geographically restricted to only one or a few caves (local endemisms). This distribution pattern contrasts with that of the nine species found along the Italian Peninsula, most of which have a wider distribution often including several caves. While we cannot exclude that this contrast might be partially biased by a general lack of detailed studies on the distribution of *Dolichopoda* in continental Greece, the fact remains that a number of Ionian and Aegean insular

geographic region/ species	Mace-donia	Thes-saly	Thasos	Epirus	Ionian Isl.	A.Acar-nania	C. Greece	Pelo-ponnese	Spora-des	Cycla-des	Rhodes	Crete
DOLICHOPODA												
D. hussoni	X											
D. remyi	X											
D. annae		X										
D. thasosensis			X									
D. graeca				X								
D. kiriakii				X								
D. steriotisi					X							
D. gasparoi					X							
D. giachinoi					X							
D. ithakii					X							
D. pavesii					X							
D. patrizii						X						
D. lustriae						X						
D. matsakisi								X				
D. dalensi								X				
D. vandeli							X					
D. insignis							X					
D. petrochilosi							X					
D. makrikapa							X					
D. cassagnaui							X					
D. ochtoniai							X					
D. saraolakosi								X				
D. unicolor								X				
D. naxia										X		
D. calidnae									X			
D. kalithea									X			
D. giulianae									X			
D. paraskevii												X
TROGLOPHILUS												
T. (P.) neglectus (?)	X											
T. (T.) zoiai							X					
T. (T.) marinae										X		
T. (T.) lagoi							X				X	
T. (T.) spinulosus												X

Table 1. List of Rhaphidophoridae presently known in Greece. (?) refers to the uncertain presence of *T. (P.) neglectus* in Greece.

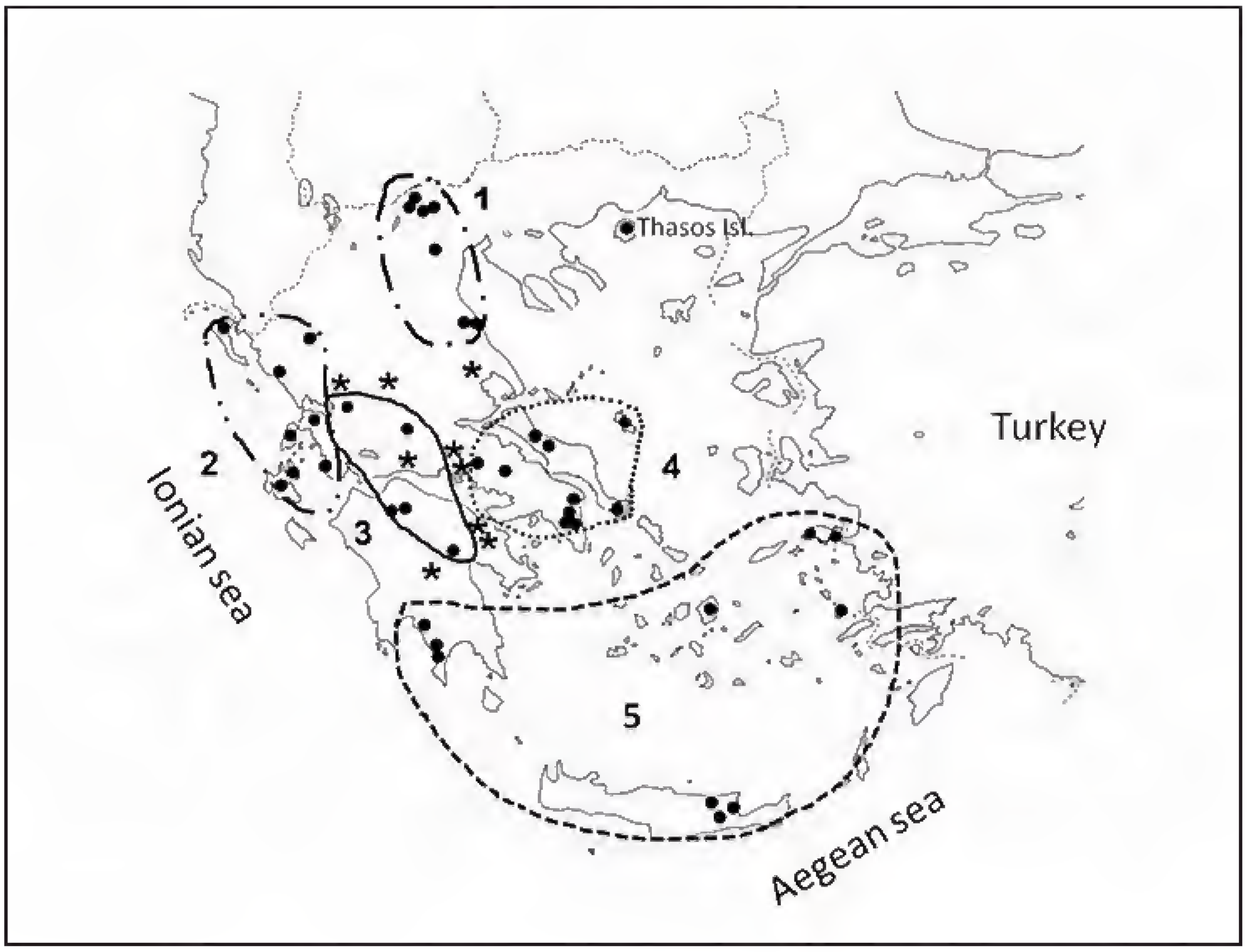


Figure 88. Geographic distribution of *Dolichopoda* in Greece. Black circle: present distribution of known species; asterisk: *Dolichopoda* sp.; the numbers refer to the geographic grouping of the species.

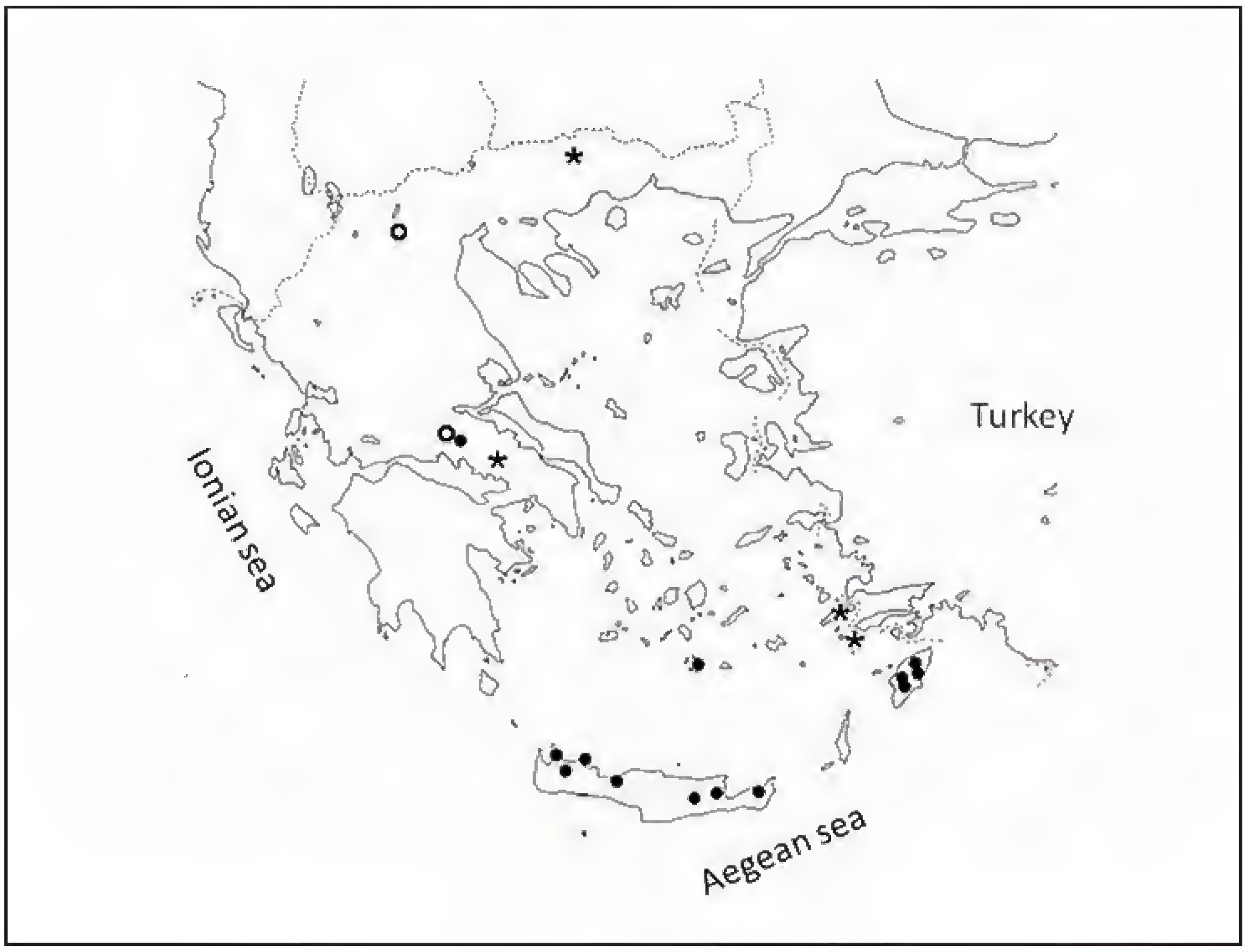


Figure 89. Geographic distribution of *Troglophilus* in Greece. Black circle: present distribution of known species; asterisk: *Troglophilus* sp.; white circle: localities of historical records.

species are naturally restricted to small islands. Furthermore, the thermo-xerophilic climate characterizing most of the southern Balkan Peninsula and the high fragmentation of the karstic areas in Greece could have played an important role in preventing gene flow among cave cricket populations, leading to strong isolation and ultimately multiple local speciation events. This scenario is further supported by the fact that all the Greek *Dolichopoda* species are highly dependent on caves, as indicated by a suite of morpho-physiological traits. The hind femur/pronotum length ratio, commonly used as a measure of cave specialization (Leroy, 1967; Di Russo & Sbordoni, 1998), is on average 6.7, substantially higher than the corresponding values for other groups of species (5.91 for Italian peninsular species and 4.67 for the trans-Caucasian species).

Only two of the five species of *Troglophilus* are present in continental Greece, with a very scattered geographic distribution including a few mountain localities of Northern and Central Greece (Fig. 89). The remaining three species are widespread throughout Crete and some Aegean islands. As reported in the previous taxonomic list, *T. cavicola* and *T. neglectus*, two typical Balkan species, are cited for single localities in the continental part of Greece. However, on the basis of our investigations and the results reported herein, we would refer the historical records of *T. cavicola* for Mount Parnassos (Brunner von Wattenwyl, 1888) and Mount Oiti (Chopard, 1932) to the new species *T. zoiai*, here described from the Dragon Cave on the slope of Mount Parnassos and from the nearby Mount Vardousia.

The new species can be readily distinguished from *T. cavicola* by the shape of the female subgenital plate and ovipositor. Furthermore, the female tergum X lacks the two expansions typical of both *T. neglectus* (Fig. 66) and *T. cavicola* (Fig. 71). On the other hand, according to the illustration of the male tergum X reported by Maran (1958), the record of *T. neglectus* from Naousa should probably be assigned to *T. zorae*, recently described for some localities in Macedonia and Serbia (Karaman et al., 2012). All the Aegean species form a homogeneous group inhabiting caves on the islands of Crete, Santorini and Rhodes and sharing some morphological characters with the southern Anatolian species such as the shape of the male tergum X and the female ovipositor. However, they are all clearly differentiated by the shape of the female subgenital plate and, as in the case of *T. spinulosus* and *T. marinae*, the femur armed with a series of spines. The latter character is also present in one Anatolian species, *T. ferzenensis*, recently described for Southern Turkey (Taylan et al., 2012). Interestingly the two genera *Dolichopoda* and *Troglophilus* inhabit the same caves in some localities of Crete, e.g. the Milatos and Atziganospilios caves in the eastern part of the island. As reported in a phylogenetic analysis conducted on most of the known species (Ketmaier et al., 2002, 2012), all the Aegean species of *Troglophilus* cluster in a basal monophyletic clade. This suggests, as already found in *Dolichopoda*, a first center of dispersal corresponding to the ancient Aegean plate. Karaman et al. (2012) reached the same conclusion but also hypothesized a second center of dispersal in the northern part of the Balkan Peninsula (Macedonia and Serbia).

APPENDIX

Key of the Greek Rhaphidophoridae

1 Metatarsus of the hind legs with an apical spine..2

- Metatarsus of the hind legs without an apical spine; hind legs and palps very long..................................Gen. *Dolichopoda*

2 Knees of the hind and middle legs without a mobile spine..........................Gen. *Troglophilus*

Genus ***Dolichopoda***

1 Hind femur with numerous spines (20-25) on ventral edge..2

- Hind femur without spines on ventral edge..3

2 Tergum X with two enlarged tubercles; basal process of epiphallus wing-shaped...*D. lustriae*

- Tergum X with two pronounced rounded ridges; epiphallus long with acute apex........*D. remyi*

3 Epiphallus bifid at the apex...............................4

- Epiphallus not bifid at the apex, long and cylindrical, basal process developed..................5

- Epiphallus not bifid, quite flattened, basal process poorly developed..6

4 Rounded tergum IX covering tergum X............. ....*D. vandeli*

- Trapezoidal tergum IX covering tergum X; lateral lobes of tergum X truncate at the apex........... ....*D. petrochilosi*

- Trapezoidal tergum IX covering tergum X; lateral lobes of tergum X acute at the apex...*D. makrikapa*

- Tergum IX with long process rounded at the apex, epiphallus large and flattened with a wide bifurcation at the apex......*D. insignis*

- Epiphallus short, massive, with a typical X-shape ....*D. cassagnaui*

5 Tergum X with two evident tubercles of different shape..7

- Tergum X with elevated ridges.........................8

6 Epiphallus quite wide and flattened, tergum X with rounded lateral lobes...........*D. unicolor*

- Tergum X with squared lobes.........*D. giulianae*

- Tergum X with triangular lobes....*D. paraskevii*

- Tergum X with triangular lobes separated by a large concavity............................*D. kalithea*

- Tergum X with short triangular lobes, epiphallus moderately wide and flattened, rounded at the apex..*D. naxia*

- Tergum X with large triangular lobes, epiphallus moderately wide and flattened, acute at the apex...*D. calidnae*

7 Tergum X with two evident conical tubercles, epiphallus large at the base............*D. graeca*

- Tergum X with two conical tubercles connected by a crest..................................*D. giachinoi*

- Tergum X with two small conical tubercles, epiphallus slender and acute at the apex...*D. steriotisi*

- Tergum X with two larger conical tubercles, subgenital plate without styli..........*D. ithakii*

- Tergum X with two cylindrical tubercles, epiphallus large at the base...........*D. kiriakii*

- Tergum X with two cylindrical tubercles, squared lateral lobes.....................*D. pavesii*

- Tergum X with two pyramidal tubercles and squared lobes, basal lobes of epiphallus poorly developed and wing-shaped ....*D. matsakisi*

- Tergum X with two pyramidal tubercles, trapezoidal lobes with sinuous posterior margins, basal lobes of epiphallus well developed ... ... *D. dalensi*

8 Tergum X with two folded ridges, tergum IX deeply incised... ... ...*D. annae*

- Tergum X with two curved ridges, epiphallus thin and acute ... ...*D. hussoni*

- Tergum X with two small crests linking the posterior edges of the lateral lobes...*D. gasparoi*

* Due to the lack of recent material useful for a correct comparison with the other species, *D. thasosensis* is not included in this key.

Genus ***Troglophilus***

1 Middle tibia with spines on the dorsal side.... ... ...Subgenus *Troglophilus* 2

- Middle tibia without spines on the dorsal side; tergum X characterized by two protruding triangular lobes, copulatory organ membranous, triangular in shape, first article of the metatarsus with 8 spines on the upper margin; female subgenital plate short and trapezoidal, ovipositor 8-9 mm long with acute apex and 12 denticles on the inner valves................ ....*T. (Paratroglophilus) neglectus*

2 Fore and middle femora with a series of short spines..4

3 Fore and middle femora without short spines

- Male tergum X short with reduced lateral lobes separated by a slight concavity, first article of the metatarsus with 8 spines on the upper margin; female subgenital plate triangular and rounded apically, ovipositor 8 mm long with 8 denticles on the inner valves....*T. (T.) lagoi*

- Female subgenital plate squared with a concave posterior margin, ovipositor relatively short (10 mm) and almost entirely enlarged with 11-12 strong denticles on the inner valves ....*T. (T.) zoiai*

4 Male tergum X short, first article of metatarsus with 5 spines on the upper margin; female subgenital plate triangular, wide at the base and slightly incised at the apex, ovipositor wide, 10 mm long with 9 denticles on the inner valves ... .*T.* (*T.*) *marinae*

\- Male tergum X short with a wide concavity in the middle, first article of the metatarsus with 7 spines on the upper margin; female subgenital plate triangular, slightly bilobate, ovipositor 12.5 long with 8 denticles on the inner valves ....*T.* (*T.*) *spinulosus*

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REFERENCES

Allegrucci G., Rampini M., Gratton P., Todisco V. & Sbordoni V., 2009. Testing phylogenetic hypotheses for reconstructing the evolutionary history of *Dolichopoda* cave crickets in the eastern Mediterranean. Journal of Biogeography, 36: 1785–1797. doi: 10.1111/j.1365-2699.2009.02130.x

Boudou-Saltet P., 1970. Les Dolichopodes (Orth. Rhaph.) de Grèce. 11. Une nouvelle espèce: *D. vandeli*. Biologia gallo-hellenica, 3: 89–97.

Boudou-Saltet P., 1971a. Les Dolichopodes de Grèce. 111. *Dolichopoda cassagnaui* n. sp., Bulletin de la Société d'Histoire naturelle de Toulouse, 107: 295–300.

Boudou-Saltet P., 1971b. Les Dolichopodes de Grèce. 1V. Decouverte de la femelle de *D. insignis* Chop., Bulletin de la Société d'Histoire naturelle de Toulouse, 107: 615–618.

Boudou-Saltet P., 1972a. Les Dolichopodes (Orth. Rhaph.) de Grèce. V. Deux nouvelles espèces: *Dolichopoda naxia* et *D. steriotisi*. Biologia gallo-hellenica, 4: 99–108.

Boudou-Saltet P., 1972b. Les Dolichopodes (Orth. Rhaph.) de Grèce. VII. Nouvelles espèces du Péloponnèse. Bulletin de la Société d'Histoire naturelle de Toulouse, 108: 420–425.

Boudou-Saltet P., 1973a. Les Dolichopodes (Orth. Rhaph.) de Grèce. V1, *D. annae*, nouvelle espèce de Thessalie. Biologia gallo-hellenica, 4: 169–174.

Boudou-Saltet P., 1973b. Les Dolichopodes (Orth. Rhaph.) de Grèce. V11. Nouvelles espèces de Crete. Biologia gallo-hellenica, 5: 57–63.

Boudou-Saltet P., 1978. Sur les Troglophiles (Orth. Cavernicoles) de Crete. Bulletin de la Société d'Histoire Naturelle de Toulouse, 114: 115–121.

Boudou-Saltet P., 1980. Les Dolichopodes (Orth. Rhaph.) de Grèce. IX. Une espèce nouvelle en Eubee: *D. makrykapa*. Biologia gallo-hellenica, 9: 123–134.

Boudou-Saltet P., 1983. Sur les *Dolichopoda* (Orth. Rhaph.) du sous-genre *Petrochilosina*. Mémoire de Biospeleologie, 10: 321–323.

Brunner von Wattenwyl C., 1888. Monographie der Stenopelmatiden und Gryllacriden. Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft, 38: 298–299.

Casale A., Rampini M., Di Russo C. & Delitala G.M., 2005. *Dolichopoda muceddai* Rampini & Di Russo, nuova specie di una famiglia di Ortotteri nuova per la Sardegna (Orthoptera, Rhaphidophoridae). Bollettino della Società entomologica Italiana, 137: 75–92.

Chopard L., 1921. Description d'une espèce nouvelle du genre *Troglophilus* (Orth. Phasgonuridae). Bullettin de la Société entomologique de France, 1921: 147–151.

Chopard L., 1932. Les orthoptéres cavernicoles de la faune paleartique. Archives de Zoologie Experiméntale et générale, 74: 263–286.

Chopard L., 1934. Diagnoses d'Orthoptères cavernicoles nouveaux. Bullettin de la Société entomologique de France, 39: 137–139.

Chopard L., 1954. Contribution a l'etude des Orthoptères cavernicoles. Notes biospeologiques, 9: 27–36.

Chopard L., 1955. Les Dolichopodes de Grece. Notes biospeologiques, 10: 31–34.

Chopard L. 1964. Description d'Orthoptères cavernicoles de Grece. Bullettin de la Société entomologique de France, 69: 17–20.

Di Russo C. & Sbordoni V., 1998. Gryllacridoidea. In: Juberthie C., Decu V. (Eds.), Encyclopedia Biospeleologica, Vol. II, Moulis, Bucarest, pp. 989–1001.

Di Russo C. & Rampini M., 2014. New record of *Dolichopoda* from Northern Iran (Orthoptera, Rhaphidophoridae). Fragmenta entomologica, Roma, 45: 1–3.

Eades D.C., Otte D., Cigliano M.M. & Braun H., 2014. OSF: Orthoptera Species File Online (version 5.0/5.0). http:/Orthoptera.SpeciesFile.org.

Galvagni A., 2002. Una nuova *Dolichopoda* (s. str.) di Grecia: *D. pavesi* n. sp. dell'isola di Kefallenia (Insecta Orthoptera Rhaphidophoridae). Atti dell' Accademia Roveretana degli Agiati, a. 252, ser. VIII, vol. II, B: 5–16.

Karaman I., Hammouti N., Pavicevic D., Kiefer A., Horvatovic M. & Seitz A., 2012. The genus *Troglophilus* Krauss, 1879 (Orthoptera: Rhaphidophoridae) in the West Balkans. Zoological Journal of the Linnean Society, 163: 1035–1063.

Ketmaier V., Cobolli M., De Matthaeis E. & Rampini M., 2002. Biochemical systematics and patterns of genetic divergence between the *Troglophilus* species of Crete and Rhodes (Orthoptera, Rhaphidophoridae). Belgian Journal of Zoology, 130 (supplement): 49–53.

Ketmaier V., Di Russo C., Rampini M. & Cobolli M., 2012. The cave crickets genus *Troglophilus* (Orthoptera, Rhaphidophoridae) a combination of vicariance and dispersal drove diversification in the East Mediterranean area. 21st International Conference on Subterranean Biology, 2–7 September 2012, Kosice, Slovakia. Abstract book, p. 56.

Kollaros D., Paragamian K. & Legakis A., 1991. Revision of the genus *Troglophilus* (Orthoptera, Rhaphidophoridae) in Crete, Greece. International Journal of Speleology, 20: 37–45.

Krauss H., 1879. Die Orthopteren-Fauna Istriens, Sitzungs-berichte der Osterreichischen Akademie der Wis- senschaften. Mathematisch-Naturwissenschaftliche Klasse (Abte.1). 1, 78: 451–542.

Leroy Y., 1967. Gryllides et Gryllacrides cavernicoles. Annales de Spéléologie, 22: 659–722.

Maran J.,1958. Beitrage zur Kenntnis der Geographischen Variabilitat von *Troglophilus neglectus* Krauss. Orthoptera Rhaphidophoridae. Acta Entomologica Musei Nationalis Pragae, 32: 387–393.

Menozzi C., 1935. Nuovi contributi alla conoscenza della fauna delle isole italiane dell'Egeo. IV. Una nuova specie di *Troglophilus* Krauss di Rodi (Orthoptera-Phasgonuridae). Bollettino del Laboratorio di Zoologia Generale e Agraria, 28: 192–196.

Rampini M. & Di Russo C., 2003a. Una nuova specie del genere *Troglophilus* Krauss, 1879 (Orthoptera, Rhaphidophoridae) delle Cicladi, Grecia. Bollettino del Museo Civico di Storia Naturale di Verona, 27, Botanica Zoologia: 23–29.

Rampini M. & Di Russo C., 2003b. Una nuova specie di *Troglophilus* di Turchia (Orthoptera, Rhaphidophoridae). Fragmenta entomologica, 34: 235–247.

Rampini M., Di Russo C., Pavesi F. & Cobolli M., 2008. The genus *Dolichopoda* in Greece. A characters of new species from the Ionian Regions and Peloponnese (Orthoptera, Rhaphidophoridae). Zootaxa, 1923: 1–17.

Rampini M., Di Russo C., Taylan M.S., Gelosa A. & Cobolli M., 2012. Four new species of *Dolichopoda* Bolivar 1880, from Southern Sporades and Western Turkey (Orthoptera, Rhaphidophoridae, Dolichopodainae). ZooKeys, 201: 43–58.

Rampini M. & Di Russo C., 2012. Famiglia Rhaphidophoridae Walker, 1871. In: Massa B., Fontana P., Buzzetti F.M., Kleukers R. & Odé B., 2012 (Eds.). Fauna d'Italia. Orthoptera. Vol. 48. Calderini, Bologna, pp. 312–327.

Ruffo S., 1955. Le attuali conoscenze della fauna cavernicola della regione pugliese. Memorie di Biogeografia Adriatica, 3: 1–143.

Sbordoni V., Allegrucci G. & Cesaroni D., 2005. Population structure of cave organisms. In: D. Culver and W. White (Eds.) "The Encyclopedia of Caves", Elsevier Academic Press, pp. 447–455.

Taylan M.S., Di Russo C., Cobolli M. & Rampini M., 2012. New species of the genus *Troglophilus* Krauss, 1879 (Orthoptera: Rhaphidophoridae) from Western and Southern Anatolian caves, Turkey. Zootaxa, 3597: 33–40.

Werner F., 1927. Beitrage zur Kenntnis der Fauna Griechenlands (Reptilia-Amphibia-Scorpiones-Orthoptera-Isoptera-Apterygota). Zoologischer Anzeiger, 70: 135–151.

Willemse F., 1984. Fauna Graeciae I. Catalogue of the Orthoptera of Greece. Hellenic Zoological Society, Athens, (pp. 88–92), 275 pp.

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On the presence of *Buprestis* (*Ancylocheira*) *cupressi* Germar, 1817 (Coleoptera Buprestidae) in Sicily, Italy

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ABSTRACT *Buprestis* (*Ancylocheira*) *cupressi* Germar, 1817 (Coleoptera Buprestidae) had already been reported in the past for Sicily (Italy), but it had been excluded from more recent catalogues because of lack of evidence. In the present paper the occurrence of the species in Sicily is confirmed by some findings in Vendicari (Siracusa province). Moreover, it is emphasized the importance of the dunal environments of Vendicari as regards the preservation of the insect fauna.

KEY WORDS distribution; Buprestidae; Sicily.

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INTRODUCTION

Buprestis (*Ancylocheira*) *cupressi* Germar, 1817 (Coleoptera Buprestidae) is a species with an East European geographical range (cf. Kubán, 2005), already known in Italy for Liguria, Veneto, Friuli Venezia Giulia, Latium, Campania, Apulia, Basilicata and Tuscany (Porta, 1929; Luigioni, 1929; Gerini, 1953; Gobbi, 1970; 1983; Curletti, 1984; 2006).

Regarding Sicily, there were only old, generic and never proved reports (Bertolini De, 1872; 1899; Heyden et al., 1883, 1891; Porta, 1929).

B. cupressi was first mentioned for Sicilian fauna in the "Catalogo sinonimico e topografico dei coleotteri d'Italia" by Bertolini (1872: sub *Ancylochira cupressi* Germ., Si[cilia]). Bertolini, in his work (1872), refers to Sicily as the only Italian region where *B. cupressi* can be found, wrongly mentioning or even overlooking the type locality indicated by O.G. Costa (1839) for *Ancylochira mutabilis*. Describing this species, later reduced to synonymy with *B. cupressi* by Kraatz (1857), O.G. Costa (1839) indicates San Cataldo near Lecce as the collection area: "*Trovasi sul Giunipero Sabina presso Lecce. L'ho raccolta nelle macchie di S. Cataldo…*"

De Marseul (1865) wrongly cites the location area indicated by O.G. Costa (1839) reporting: "*Terre d'Otrante, Sabina prés Lecce, sur le Genévrier*"; in fact in Costa's note "*Sabina*" is not a location near Lecce but refers to "*Giunipero Sabina*" which is the Cupressacea *Juniperus sabina* L. (see also Ragusa, 1893).

Ragusa already thought that Bertolini's record, used by Heyden et al. (1883, 1891) as well, could be the outcome of a misunderstanding; in fact in his "Catalogo ragionato dei Coleotteri di Sicilia" (1893) he wrote: "*…Nel catalogo del de Bertolini e in quello di Berlino* [Catalogus Coleopterorum Europae: Caucasi Et Armeniae Rossicae" di Heyden et al., 1891], *troviamo pure la* B. cupressi *Germar al sinonimo* mutabilis *Costa, citata di Sicilia. Dubito sia un errore avendola il de Marseul citata*

di Italia, solamente di Sabina, presso Lecce". Ragusa (1904) confirmed his opinion later "*Dissi già (cat. rag.) che l'*Ancylochira cupressi *Germ. fu citata di Sabina presso Lecce e non di Sicilia*".

These observations were acknowledged by Luigioni (1929) who removed *B. cupressi* from Sicilian fauna, but not by Porta (1929) who insisted reporting the species for Sicily. Later, other authors mentioned *B. cupressi* for Sicily (see also Zocchi, 1956; Acatay, 1961; Browne, 1968), we don't know whether according to the original wrong report or to never recorded evidence.

Currently, *B. cupressi* is excluded from the more recent catalogues for lack of sure evidence (Curletti, 1984; 2006; Gobbi & Platia, 1995; Curletti et al., 2003; Kubán & Bily, 2004; Kubán, 2005). In the present paper we report new findings of the species in the "Riserva Naturale Orientata Oasi Faunistica" of Vendicari (Siracusa, Sicily, Italy).

Buprestis (*Ancylocheira*) *cupressi* Germar, 1817 in Sicily

EXAMINED MATERIAL. Italy, Sicily, Siracusa, Vendicari, Lat. 36°48'13"N, Long. 15°5'49"E, 19.VII.2014, leg./coll. C. Muscarella; idem, 26.VII.2014 leg./coll. I. Sparacio.

The specimens (Fig. 1) were collected in-flight or on the juniper foliage (Fig. 2), in the sun, during the hottest hours of the day, behind the coastal dunes in Vendicari (Siracusa, Sicily, Italy). This environment is characterized by the "macchia-foresta" (maquis-forest) vegetation, with a prevailing occurrence of *Juniperus oxycedrus* L. ssp. *macrocarpa* (Sibth & Sm.) Ball., *Pistacia lentiscus* L. and *Ephedra fragilis* (Federico, 2006). This is the typical habitat in Italy for *B. cupressi* (Tassi, 1962), mostly comprising the thick shrubs of *Juniperus*, main source of nourishment for the species both at its larval and adult stage (Gobbi, 1986). Anyway, *B. cupressi* also adapted to various allochthonous plant species including *Cupressus* sp. and *Cedrus* sp. (Zocchi, 1956; Tassi, 1962; Gobbi, 1970; 1986), widely spread as ornamental in parks and cemeteries, thus moving far away from its usual Mediterranean area (Gobbi, 1986; 1992).

Targeted studies on both cypress grooves and suitable habitats in Sicily, aimed at collecting *B. cupressi* specimens, have given negative results until now (Sparacio com. pers). The cause of this supposed rarefaction of the species can be found both in demographic fluctuations, due to pullutants able to cause serious damage to cultivated Cupressacee (Zocchi,1956; Acatay, 1961; Browne, 1968; Covassi et al., 1998), and, mostly, in the degradation of the typical habitat.

The phytocenosis of *Ephedro-Juniperetum macrocarpae* Bartolo, Brullo et Marcenò 1982, was typical of the dunal system in almost all Sicilian sandy shores until the first half of 1900, but it has been gradually destroyed and reduced into small relict areas (Riggio & Massa,1975; Lapiana & Sparacio, 2008) by the massive anthropic interference and the overbuilding of the shores.

The finding of *B. cupressi* confirms then the importance of Vendicari reserve as a refuge area for

Figure 1 (upper). *Buprestis* (*Ancylocheira*) *cupressi* from Vendicari, Sicily, Italy. Figure 2 (right). *Juniperus oxycedrus* L. ssp. *macrocarpa* (Sibth & Sm.) Ball. from Vendicari, Sicily, Italy (photo by Michele Torrisi).

many umbrella-species of insects - elsewhere heavily decreasing (Sabella, 1993; Bella et al., 2009; Petralia, 2010). Moreover, it plays an important role in the characterization of this important fauna of biotope, being *B. cupressi*, as already stated before, connected to juniper, one of the most typical and most threatened plants of the Sicilian dunal system, for its life cycle.

CONCLUSIONS

Present documented evidence let us include *B. cupressi* among the Sicilian buprestid fauna, for which the *Buprestis* Linnaeus, 1758 genus is represented in Sicily also by *B.* (*Ancylocheira*) *haemorrhoidalis araratica* Marseul, 1865, *B.* (*Ancylocheira*) *novemmaculata* Linnaeus, 1767 and *B.* (*Buprestis*) *aetnensis* Baviera et Sparacio, 2002 (Curletti, 1984; Gobbi & Platia, 1995; Curletti, 2006).

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REFERENCES

Acatay A., 1961. Über einige Zedernschädlinge in der Türkei. Anzeigerfür Schädlingskunde, 34: 1–6.

Bella S., Parenzan P. & Russo P., 2009. I Macrolepidotteri della Riserva Naturale Regionale di Vendìcari (Sicilia Sud-orientale). Contributi alla conoscenza della lepidotterofauna siciliana XI. Entomologica, Bari, 41 (2008-2009): 113–193.

Bertolini De S., 1872. Catalogo sinonimico e topografico dei coleotteri d'Italia. Tipografia cenniniana, Firenze, 116 pp.

Bertolini S., 1899. Catalogo dei Coleotteri d'Italia. Rivista italiana di Scienze Naturali, Siena, 144 pp.

Browne F.G., 1968. Animals as pests of forest plantation trees. In: Brown F.G. (Ed.), Pests and diseases of forest plantation trees: an annotated list of the principal species occurring in the British Commonwealth. Clarendon Press, Oxford, 729 pp.

Costa O.G., 1839. Degli insetti nuovi e rari della provincia di Terra d'Otranto. Atti della Reale Accademia delle Scienze, Napoli, IV: 5–19. [1827]

Covassi M.V., Roversi P.F. & Binazzi A., 1998. Diffusione e risposte adattative di insetti xilofagi nel mutato quadro fitosanitario di *Cupressus sempervirens*. In: "Il nostro amico cipresso", Giornata di studio e aggiornamento sulle avversità del *Cupressus sempervirens* L., Firenze, 14 maggio 1998, Annali Accademia Italiana Scienze Forestali, 46: 77–91.

Curletti G., 1984. I Buprestidi d'Italia. Catalogo Tassonomico, Sinonimico, Biologico, Geonemico. Monografie di Natura Bresciana, 19, Ed. Vannini, Brescia, 318 pp.

Curletti G., 2006. Coleoptera Buprestidae. In: Stoch F. (Ed.), 2000-2006. CKmap for Windows. Version 5.3. Ministry for Environment, Territory and Sea, Nature Protection Directorate, http://ckmap.faunaitalia.it

Curletti G., Rastelli M., Rastelli S. & Tassi F., 2003. Coleotteri Buprestidi d'Italia. Piccole Faune. Museo Civico di Storia Naturale di Carmagnola (Torino) e Progetto Biodiversità Comitato Parchi - Centro Studi (Roma), CD-ROM.

Federico C., 2006. La flora della riserva naturale di Vendicari. Industria grafica T. Sarcuto, Agrigento, 222 pp.

Gerini F., 1953. Note sui Buprestidi italiani I. Bollettino della Società Entomologica Italiana, 82: 85–91.

Gobbi G., 1970. Contributo alla conoscenza dei Coleotteri Buprestidi d'Italia (Col. Buprestidae). Bollettino dell'Associazione Romana di Entomologia, 25: 35–45.

Gobbi G., 1983. Interessanti reperti di buprestidi italiani e diagnosi di *Anthaxia liae* n. sp. Coleoptera, Buprestidae. Bollettino dell'Associazione Romana di Entomologia, 36: 33–41.

Gobbi G., 1986. Le piante ospiti dei Buprestidi italiani. Primo quadro d'insieme (Coleoptera: Buprestidae). Fragmenta entomologica, 19: 169–265.

Gobbi G., 1992. I Buprestidi del Lazio. Bollettino dell' Associazione Romana di Entomologia, 47:39-74.

Gobbi G. & Platia G., 1995. Coleoptera Polyphaga VII (Elateroidea, Buprestoidea). In: Minelli A., Ruffo S. & La Posta S. (Eds.), Checklist delle specie della fauna italiana, 52. Calderini, Bologna.

Heyden L. von, Reitter E. & Weise J., 1883. Catalogus Coleopterorum Europae et Caucasi. Editio tertia. London, Edw. Janson; Berlin, Nicolai; Paris, Buquet. 228 pp.

Heyden L. von, Reitter E. & Weise J., 1891. Catalogus Coleopterorum Europae, Caucasi et Armeniae Rossicae. Berlin, R. Friedländer & Sohn; Mödling, Edmund Reitter; Caen, Revue d'Entomologie, VIII + 420 pp.

Kraatz G., 1857. Synonymische Bemerkungen. Berliner entomologische Zeitschrift, 1: 175–180.

Kubán V., 2005. Buprestidae (Buprestinae without Anthaxiini). In: Löbl I. & A. Smetana A. (Eds.): Catalogue of Palaearctic Coleoptera, Vol. 3. Stenstrup, Apollo Books, pp. 381–388.

Kuban V. & Bily S., 2004. Fauna Europaea: Buprestidae. In: Alonso-Zarazaga M.A. (Ed.), Fauna Europaea: Coleoptera 1. Fauna Europea Version 1.0, http://www.faunaeur.org [Accessed 1 VIII 2014].

Lapiana F. & Sparacio I., 2008. Lo studio degli insetti nella valutazione della naturalità degli ambienti dunali costieri in Sicilia: Coleoptera e Orthoptera. Il Naturalista siciliano, 22: 411–434.

Luigioni P., 1929. I Coleotteri d'Italia. Catalogo sinonimico, topografico-bibliografico. Memorie della Pontificia Accademia delle Scienze - I Nuovi Lincei, 13, 1160 pp.

Marseul de S.A., 1865. Monographie des buprestides d'Europe, du nord de l'Afrique et de l'Asie. L'Abeille, Mémoires d'Entomologie 2, 540 pp.

Petralia A. (cur.), 2010. Area Protetta di Vendicari. Atti del Convegno celebrativo per il 35° anno di fondazione dell'Ente Fauna Siciliana ("Case Cittadella", Vendicari - Noto, 25-26 ottobre 2008). Due Elle Grafica & Stampa, Siracusa, 432 pp.

Porta A., 1929. Fauna Coleopterorum italica. Vol.III, Diversicornia. Stabilimento tipografico Piacentino, Piacenza, 466 pp.

Ragusa E., 1893. Catalogo ragionato dei Coleotteri di Sicilia (Buprestidae). Il Naturalista siciliano, 12: 289–301.

Ragusa E., 1904. Osservazioni su alcuni Coleotteri di Sicilia, notati o omessi nel nuovo Catalogo dei Coleotteri d'Italia del Dott. Stefano Bertolini (Siena 1899). Il Naturalista siciliano, 17: 1–8.

Riggio S. & Massa B., 1975. Problemi di conservazione della natura in Sicilia. 1° contributo per un'analisi della degradazione ambientale ed elenco delle aree dell'isola di maggiore interesse naturalistico. Atti IV Simposio nazionale Conservazione della Natura, Bari, 2: 299–425.

Sabella G., 1993. I Coleotteri Pselafidi della riserva naturale di Vendicari. Atti e Memorie dell'Ente Fauna Siciliana, 1: 79–94.

Tassi F., 1962. Appunti per una migliore conoscenza dei Coleotteri Buprestidi del Lazio. Bollettino dell'Associazione romana di Entomologia, 17: 25–27.

Zocchi R., 1956. Insetti del Cipresso. I. Il Gen. *Phloeosinus* Chap. (Coleoptera Scolytidae) in Italia. Redia, 41: 129–225.

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A new record of the Red swamp crayfish, *Procambarus clarkii* (Girard, 1852) (Crustacea Cambaridae), in Sicily, Italy

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ABSTRACT The Red swamp crayfish, *Procambarus clarkii* (Girard, 1852), is a decapod crustacean native of the United States and Northern Mexico that was introduced in several countries of the world. This species are known to have detrimental effects on invaded ecosystems. The Red swamp crayfish was found for the first time in Sicily in 2012, inside the Nature Reserve "Lago Preola e Gorghi Tondi" (Trapani province). This paper describes the discovery of a second population of this species at the "Rosamarina" reservoir (Palermo province), whose origin appears to be independent of the first one. This new finding emphasizes the need for extensive survey in Sicily and the development of an adequate action plan for containment or eradication of this species.

KEY WORDS monitoring; wildlife management; protected areas; mapping.

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INTRODUCTION

The Red swamp crayfish, *Procambarus clarkii* (Girard, 1852), is a decapod crustacean belonging to the Cambaridae family; it is native to the Southern and Central United States of America, and to Northern Mexico (Souty-Grosset et al., 2006). Because of its frequent use for fishery production and pet/aquarium trade, in the last decades it was introduced in several South-American, African, Asian and European countries (Hobbs et al., 1989).

In Europe, the species was first introduced in 1973 in southern Spain (Ackefors, 1999; Souty-Grosset et al., 2006). It soon became widely spread in the whole Iberian Peninsula and was then introduced in France, Germany, Switzerland, Austria, Belgium, the Netherlands, Czech Republic, United Kingdom and, probably, Cyprus (Souty-Grosset et al., 2006). In Italy, the first reproductive population of the species was found in Piedmont in the early '90s (Del Mastro, 1992); afterwards, it successfully invaded most of the Italian Peninsula and Sardinia (e.g. Froglia, 1995; Mazzoni et al., 1996; Aquiloni et al., 2010).

In Sicily, the first record of a naturalized population of the Red swamp crayfish was reported by D'Angelo & Lo Valvo (2003) for the Nature Reserve "Lago Preola e Gorghi Tondi" (Trapani province). There, despite several attempts aimed at the eradication of this population, the species is still present with a thriving population.

RESULTS

In October 2012 a single, gravid, *P. clarkii* female was collected by an angler (L. Sapienza, pers.

comm.) in the "Rosamarina" reservoir (Palermo province, UTM WGS84 33S 381200 - 4201700), a large man-made lake located approximately 95 km NE of the only other known Sicilian occurrence site of the species (D'Angelo & Lo Valvo, 2003) (Fig. 1). "Rosamarina" is a mesotrophic canyon reservoir, characterised by sulphate-rich waters and scarcely pronounced water-level fluctuations (Naselli-Flores et al., 2003), it was built between 1972 and 1992 through the damming of "San Leonardo" river, and it has a maximum surface area of 5.5 km^2, with a mean depth of 19.2 m and a maximum depth of 61 m (Naselli-Flores et al., 2003).

Following the first sighting of a Red swamp crayfish in "Rosamarina" reservoir, an exploratory trapping campaign was carried out between November and December 2012, but no crayfish was captured nor observed. For the capture was used a home-made funnel trap measuring 25x30x70 cm, baited with fish fillet and canned tuna. The trap was positioned at the same point of first observation, at approximately 70 cm deep in a muddy bottom.

In May 2013 some remains of a preyed crayfish were found near the first observation site (L. Sapienza, pers. comm.) and a second sampling session was thus carried out. The trapping campaign was conducted near the first observation site, in a second site located approximately 1 km SW from the first and in a third site in "San Leonardo" river. The trapping area covered the whole length of the lake (approximately 6 km). In the frame of the second session four individuals of Red swamp crayfish (2 males and 2 females) were trapped in all the three

Figure 1. Records of Red swamp crayfish reported in Sicily: 1. Nature Reserve "Lago Preola e Gorghi Tondi" (D'Angelo & Lo Valvo, 2003); 2. "Diga Rosamarina" (present work).

	Date	E	N
1 gravid female*	20/10/2012	33S 381046	4200869
Remains	26/05/2013	33S 381304	4201154
1 male, 1 female**	31/05/2013	33S 381220	4201072
1 female**	07/06/2013	33S 381010	4200181
1 male**	14/06/2013	33S 377762	4196287

Table 1. Observations data and geographic coordinates (UTM WGS84) of Red swamp crayfish in the "Rosamarina" reservoir; *first observation, **individuals detected during the trapping campaign.

points (Table 1). Their size ranged from 98 to 115 mm in total length.

CONCLUSIONS

The discovery of several individuals in a wide area of the lake suggests the presence of a naturalized population of Red swamp crayfish. This population probably derives from a different introduction event from the one which originated the other population known for the island (D'Angelo & Lo Valvo, 2003).

Aquatic non-native species are known to have severe adverse effects on invaded ecosystems, as it was verified in Sicily for the African clawed frog, *Xenopus laevis* (Daudin, 1802) (Lillo et al., 2011). Red swamp crayfish is a polytrophic species (Ilhéu & Bernardo, 1993; Momot, 1995; Gutiérrez -Yurrita et al., 1999; Salvi, 1999), that may lead heavy modifications in food webs and specific richness (Statzner et al., 2003; Creed & Reed, 2004). Furthermore, negative effects of feeding behaviour of non-native Cambaridae are known on macrophytes asseblages, amphibians, fish, crustacean and molluscs (Seroll & Coler, 1975; Lodge & Lorman, 1987; Lodge et al., 1994; Diamond, 1996; Gherardi et al., 2001; Renai & Gherardi, 2004; Gherardi & Acquistapace, 2007). The strong burrowing activity of the species is known to cause damages on agricultural areas, dams, dykes, riparian vegetation, and it increases water turbidity (Huner, 1988; Correia & Ferreira, 1995; Anastácio & Marques, 1997; Fonseca et al., 1997).

Keeping in mind the invasiveness and the possible negative effects of the Red swamp crayfish on the already threatened Sicilian autochthonous

biota, this new finding stresses the need for the realization of sound monitoring of the species throughout the island, and the advisability of the planning of adequate management plans.

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REFERENCES

Ackefors H., 1999. The positive effects of established crayfish introductions in Europe. In: Gherardi F., Holdich D.M., 1999. Crayfish in Europe as Alien Species (How to make the best of a bad situation?). Crustacean issues 11, A.A. Balkema, Rotterdam, Netherlands, pp. 49–62.

Anàstacio P.M. & Marques J.C., 1997. Crayfish, *Procambarus clarkii*, effects on initial stages of rice growth in the lower Mondego River valley (Portugal). Freshwater Crayfish, 11: 608–617.

Aquiloni L., Tricarico E. & Gherardi F., 2010. Crayfish in Italy: distribution, threats and management. International Aquatic Research, 2: 1–14.

Correia A.M. & Ferreira O.,1995. Burrowing behaviour of the introduced red swamp crayfish *Procambarus clarkii* (Decapoda: Cambaridae) in Portugal. Crustacean Biology, 15: 248–257

Creed R.P. & Reed J.M., 2004. Ecosystem engineering by crayfish in a headwater stream community. Journal of the North American Benthological Society, 23: 224–236.

D'Angelo S. & Lo Valvo M., 2003. On the presence of the red swamp crayfish *Procambarus clarkii* in Sicily. Il Naturalista Siciliano, 27: 325–327.

Del Mastro G.B., 1992. Sull'acclimatazione del gambero della Louisiana *Procambarus clarkii* (Girard, 1852) nelle acque dolci italiane (Crustacea: Decapoda: Cambaridae). Pianura, 4: 5–10.

Diamond J.M., 1996. A-bombs against amphibians. Nature, 383: 386–387.

Fonseca J.C., Marques J.C. & Madeira V.M.C., 1997. Oxygen uptake inhibition in *Procambarus clarkii*, red swamp crayfish by biodegradable surfactants: an ecotechnological approach for population control in rice fields. Freshwater Crayfish, 11: 235–242

Froglia C., 1995. Crustacea Malacostraca III (Decapoda). In: Minelli A., Ruffo S. & La Posta S. (Eds.). Checklist delle specie della fauna italiana, 31. Calderini, Bologna.

Gherardi F., Renai B. & Corti C., 2001. Crayfish predation on tadpoles: a comparison between a native (*Austropotamobius pallipes*) and an alien species (*Procambarus clarkii*). Bulletin Français de la Pêche et de la Pisciculture, 361: 659–668.

Gherardi F. & Acquistapace P., 2007. Invasive crayfish in Europe: the impact of *Procambarus clarkii* on the littoral community of a Mediterranean lake. Freshwater Biology, 52: 1249–1259.

Gutiérrez-Yurrita P.J., Martinez J.M., Bravo-Utrera M.À., Montes C., Ilhéu M. & Bernardo J.M., 1999. The status of crayfish populations in Spain and Portugal. In: Gherardi F. & Holdich D.M. (Eds.). Crayfish in Europe as alien species. How to make the best of a bad situation? Rotterdam: A.A. Balkema, pp. 161–192.

Hobbs H.H., Jass J.P. & Huner J.V., 1989. A review of global crayfish introductions with particular emphasis on two North American species (Decapoda, Cambaridae). Crustaceana, 56: 299–316.

Huner J.V., 1988. *Procambarus* in North America and elsewhere. In: D.M. Holdich & R.S. Lowery (Eds.), Freshwater Crayfish: biology, management and exploitation. London, Chapman and Hall, 239–261 pp.

Ilhéu M. & Bernardo J.M., 1993. Aspects of trophic ecology of red swamp crayfish (*Procambarus clarkii* Girard) in Alentejo, South Portugal. Actas VI Congreso Español de Limologìa, pp. 417–423.

Lillo F., Faraone F.P. & Lo Valvo M., 2011. Can the introduction of *Xenopus laevis* affect native amphibian populations? Reduction of reproductive occurrence in presence of the invasive species. Biological Invasions, 13-7: 1533–1541.

Lodge D.M., Kershner M.W., Aloi J.E. & Covich A., 1994. Effects of an omnivorous crayfish (*Orconectes rusticus*) on a freshwater littoral food web. Ecology, 75: 1265–1281.

Lodge D.M. & Lorman J.G., 1987. Reductions in submersed macrophyte biomass and species richness by the crayfish *Orconectes rusticus*. Canadian Journal of Fisheries and Aquatic Science, 44: 591–597.

Mazzoni D., Minelli G., Quaglio F. & Rizzoli M., 1996. Sulla presenza del gambero della Louisiana *Procambarus clarkii* (Girard, 1852) nelle acque interne dell'Emilia-Romagna. In: Atti Conv. Naz. "Il contributo dei progetti di ricerca allo sviluppo dell'acqua nazionale", pp. 75–82.

Momot W.T., 1995. Redefining the role of crayfish in aquatic ecosystems. Reviews in Fisheries Science, 31: 33–63.

Naselli-Flores L., Barone R. & Mosello R., 2003. Eutrophication control by lime addition: a preliminary approach in Sicilian reservoirs. Hydrobiologia, 504: 297–303.

Renai B. & Gherardi F., 2004. Predatory efficiency of crayfish: comparison between indigenous and non-indigenous species. Biological Invasions, 6: 89–99.

Salvi G., 1999. Dieta, preferenze alimentari e potenziale impatto del gambero alloctono *Procambarus clarkii* sugli ecosistemi invasi. Master Thesis, Università di Firenze.

Seroll A. & Coler R.A., 1975. Demonstrated food preferences of *Orconectes immunis* (Hagen) (Decapoda, Astacidae). Crustaceana, 29: 319–320.

Souty-Grosset C., Holdich D.M., Noel P.Y., Reynolds J.D. & Haffner P., 2006. Atlas of Crayfish in Europe, Muséum national d'Histoire naturelle (Patrimoines naturels, 64), Paris, 187 pp.

Statzner B., Peltret O. & Tomanova S., 2003. Crayfish as geomorphic agents and ecosystem engineers: effect of a biomass gradient on baseflow and flood-induced transport of gravel and sand in experimental streams. Freshwater Biology, 48: 147–163.

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Updating the CD-rom on Coleoptera Tenebrionidae of Italy and the check-list of the same family

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ABSTRACT The authors update their recent work on Italian Tenebrionidae. At first, they present main taxonomic changes, new taxa to Italian fauna and new faunistic data, secondly they present an up to date check-list of Italian Tenebrionidae, including Sardinia and Sicily.

KEY WORDS Coleoptera; Tenebrionidae; Italy; updated check-list.

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INTRODUCTION

A few years have passed since the publication of the CD-rom on the fauna of Italy for Tenebrionidae Latreille, 1802 (Aliquò et al., 2007) and still some new data, new studies and the emergence of new ideas lead us to publish these update notes that can integrate our previous work and make it more useful to those who wish to consult it.

We are not, of course, sorry for these contingencies, but rather comforted to see how rapidly knowledge progress and many scholars devote themselves to the very same arguments that have fascinated us and filled our lives. Also, we do not exclude to re-publish, in the next future, the CD in a more complete form, perhaps taking advantage of the techniques for comparison and determination experienced in the latter CD of the series.

This paper is divided into two distinct parts. The first one includes "addenda et corrigenda" to the previous CD, excluding the numerous systematic and taxonomic changes reported in the Catalogue of Palaearctic Coleoptera (Löbl et al., 2008). The second part is the complete checklist of Tenebrionidae fauna of Italy updated from the taxonomic point of view, based on the work of Löbl et al. (2008), and including all new entities listed in the first part.

I-CD-ROM Update

Akis Herbst, 1799

Akis tuberculata Kraatz, 1865 is considered as a species distinct by *A. bacarozzo* (Schrank, 1786) by Ferrer et al. (2008). Although not reported for Italy by these authors, is probably frequent in Sardinia as it occurs throughout Corsica. We do not agree with the same authors for the synonymy of *A. italica* Solier, 1837 and *A. barbara* Solier, 1837 with *A. trilineata* Herbst, 1799.

Alphitobius Stephens, 1829

M. Violi reports the presence of *Alphitobius diaperinus* (Panzer, 1796) at Lampedusa (www.entomologiitaliani.it).

Alphitophagus Stephens, 1832

It is reported the presence of *Alphitophagus*

bifasciatus (Say, 1824) also for the Marche (Giovagnoli et al., 2012).

Ammobius Guérin-Méneville, 1844

Findings have been reported for the Marche, thus confirming the previous indication of the presence of *Ammobius rufus* (Lucas, 1846) in that region (Giovagnoli et al., 2012).

Asida Latreille, 1802

To this genus must be added the new species of *Asida*, all endemics of Sardinia and strictly localized, described by Leo (2009): *Asida* (*A.*) *dryas* (Fig. 1), *A.* (*A.*) *anachoreta* and *A.* (*A.*) *solieri* ssp. *caroli* and by Leo (2012): *A.* (*A.*) *androgyna*, *A.* (*A.*) *nurrae* and *A.* (*A.*) *paulae*. At present it is reported the presence of *A. dryas* in the area of Capoterra and S Sulcis, and E and SE of Cagliari; of *A. anachoreta* on Mount Linas (at Medio Campidano); of *A. solieri caroli* on Mount Arci at SW of Oristano, being *A. solieri solieri* limited to the coast around Gonnesa and Teulada, while in the islands of San Pietro and S. Antioco is found *A. solieri fancelloi* Leo, 1984. Additional new species are strictly localized as well: *A. androgyna* at the Southeastern end of Sardinia, in the southern part of the massif of Sarrabus including Monte dei Sette Fratelli; *A. nurrae* at Argentiera on the S coast of the Stintino peninsula and *A. paulae* in the same peninsula and in the islands of Piana and Asinara.

Blaps Fabricius, 1775

Findings from precise locations of the Marche are reported, thus confirming the previous indication of the presence of *Blaps gibba* Laporte de Castelnau, 1840, *B. lethifera* Marsham, 1802 and *B. mucronata* Latreille, 1804 in that region (Giovagnoli et al., 2012).

Boromorphus Wollaston, 1854

Gardini (2010) describes *Boromorphus italicus*, the first representative for Italy of the genus and Boromorphini tribe, present in Calabria and Basilicata.

Corticeus Piller et Mitterpacher, 1783

The presence of *Corticeus fasciatus* (Fabricius, 1790) is reported for Marche, moreover is confirmed, in the same region, the occurrence of *C. unicolor* Piller et Mitterpacher,1783 (Giovagnoli et al., 2012).

Dendarus Dejean, 1821

To *Dendarus* (*Pandarinus*) *peslieri* Soldati, 2012 (Fig. 2), described from Ionian Greece, should be attributed all populations from Apulia so far indicated as belonging to *D. coelatus* Brullé, 1832 (Soldati, 2012). On the contrary, this latter is endemic to the Peloponnese. In addition, findings of *Dendarus* (*Pandarinus*) *dalmatinus* (Germar, 1824) are reported as new record for the Marche (Giovagnoli et al., 2012).

Diaclina Jacquelin du Val, 1861

The presence of *Diaclina fagi* (Panzer, 1799) is reported for the Marche (Giovagnoli et al., 2012).

Diaperis Geoffroy, 1762

Findings from some locations of the Marche are reported, thus confirming the previous generic report on the presence of *Diaperis boleti* (Linnaeus, 1758) in that region (Giovagnoli et al., 2012).

Dichillus Jacquelin du Val, 1861

Must be added the new species described by Leo (2008): *Dichillus* (*D.*) *tyrrhenicus* (Fig. 3) and *D.* (*D.*) *tapinomae*, this latter endemic to Sardinia, known at present only of the beach and the dunes of San Giovanni di Sinis, where it lives in the nests of the ant *Tapinoma simrothi* Krausse, 1911. *D. tyrrhenicus* is spread throughout the island. All quotes of *D. corsicus* (Solier, 1838) and *D. pumilus* sensu Auctores nec Solier, 1838 for Argentario, Elba and Tuscan Islands should be referred to *D. tyrrhenicus*. Whereas reports of other *Dichillus* from Calabria, Basilicata and Campania should instead be referred to *D. corsicus* (Solier, 1838).

Elenophorus Dejean, 1821

In Löbl et al. (2008) *Elenophorus* Dejean, 1821 is replaced with *Leptoderis* Billberg, 1820, without any explanations in the introduction to the Catalogue. If the reason is, as indicated by Silfverberg (1984), only the priority of the name, we do not agree. According to the article 23.9 of the International Code of Zoological Nomenclature (ICZN, 1999), *Leptoderis* should be considered "nomen oblitum", as probably never used after its original

Figure 1. *Asida dryas*. Sardinia, Cagliari: Domusdemaria, Pixina Manna, 9.VI.2003, L. Fancello leg.

Figure 2. *Dendarus peslieri*. Apulia, Lecce, Meledugno, S. Foca-Torre dell'Orso, 25-28.VI.2007, R. Lisa leg.

description, while *Elenophorus*, which has been used consistently by all subsequent authors, should be considered "nomen protectum".

Eutagenia Reitter, 1886

The presence of *Eutagenia aegyptiaca tunisea* Normand, 1936 is reported also from Lampione islet (Lo Cascio & Pasta, 2012).

Gonocephalum Solier, 1834

A record from the Marche is reported, thus confirming the previous indication of the presence of *Gonocephalum* (*G.*) *granulatum nigrum* (Küster, 1849) in that region (Giovagnoli et al., 2012).

Latheticus Waterhouse, 1880

It is reported the capture of *Latheticus oryzae* Waterhouse, 1880 in Piedmont (Evangelista, 2011).

Leichenum Dejean, 1834

Is reported the presence of *Leichenum pictum* (Fabricius, 1801) also for the coast of Marche (Giovagnoli et al., 2012).

Melanimon Steven, 1829

Is reported the presence of *Melanimon tibiale* (Fabricius, 1781) also for the coasts of Marche (Giovagnoli et al., 2012).

Nalassus Mulsant, 1854

Is indicated the presence of *Nalassus* (*N.*) *dermestoides* (Illiger, 1798) also for the Marche (Giovagnoli et al., 2012).

Odocnemis Allard, 1876

Is reported the presence of *Odocnemis exaratus* (Germar, 1817) also for the Marche (Giovagnoli et al., 2012).

Opatrum Fabricius, 1775

G. Altadonna reports and documents the capture of *Opatrum* (*Colpophorus*) *validum validum* Rottenberg, 1871 (www.entomologiitaliani.it), on Mount Etna, E side, at Milo, thus confirming that the species is still present in Sicily, place of origin of some specimens of the typical series. *Opatrum dahli* Küster, 1849 indicated in the CD as endemic to Sardinia and Corsica, on the contrary is not present on the latter island, where is replaced by *O. malgorzatae* (Leo et al., 2011).

Pentaphyllus Dejean, 1821

Is reported the presence of *Pentaphyllus tes-*

taceus (Hellwig, 1792) in Piedmont (Evangelista, 2011).

Phaleria Latreille, 1802

Actually, the photo of *Phaleria provincialis ghidinii* Canzoneri, 1961 in the paper by Aliquò' et al. (2007) is of *Phaleria acuminata* Küster, 1852. The distribution shown for the latter species includes, incorrectly, Liguria, Emilia Romagna, Veneto and Friuli Venezia Giulia, regions for which there are no reliable reportings.

Phylan Dejean, 1821

Phylan (*P.*) *poggii* Ferrer, 2013 is described from Ischia and Southern Italy (Ferrer, 2013).

Pimelia Fabricius, 1775

Pimelia bipunctata papii Canzoneri, 1963, reported from Liguria and Tuscany, is synonymous with the typical form of *P. bipunctata* Fabricius, 1781. Its subspecies *P. bipunctata cajetana* Sénac, 1887 is instead a valid species of Central and Southern Italy (Ferrer & Castro Tovar, 2012). Also the photos in the CD are to be interpreted in this way.

Probaticus Seidlitz, 1896

Sparacio (2007) described *Probaticus cossyrensis* (Fig. 4), an endemic species from Pantelleria island, to which should be attributed the specimens from the same island previously reported as *P. anthrax* (Seidlitz, 1896).

Scaphidema L. Redtenbacher, 1849

Is reported the presence of *Scaphidema metallica* (Fabricius, 1792) for the Marche (Giovagnoli et al., 2012).

Scaurus Fabricius, 1775

Is reported the presence of *Scaurus striatus* Fabricius, 1792 and of *S. tristis* A.G. Olivier, 1795 also for the Marche, for populations which, however, might result from accidental importation (Giovagnoli et al., 2012).

Stenosis Herbst, 1799

Stenosis angusticollis elongatissima Koch, 1940 is to be considered a synonym of *S. angusticollis* (Reiche, 1861) (Leo, 2008). Findings are reported from some locations in Marche, thus confirming the previous generic indication of the presence of *S. intermedia* (Solier, 1838) in that region (Giovagnoli et al., 2012).

Tentyria Latreille, 1802

Tentyria ramburi is attributed to the subgenus

Figure 3. *Dichillus tyrrhenicus*. Sardinia, Nuoro: Villanova Strisaili, altitude 1000 m, 23.V.1974.

Figure 4. *Probaticus cossyrensis*, paratypus. Sicily, Trapani: Pantelleria, VIII.1987, V. Aliquò leg.

Subtentyrina Löbl et Merkl, 2003 (Leo, 2009). According to the same author, *T.* (*T.*) *rugosa* Gené, 1836 is a valid species, not subspecies of *T.* (*S.*) *ramburi* Solier, 1835, and to *T.* (*T.*) *rugosa* belong the subspecies *floresii* Gené, 1836 and *cassolai* Ardoin, 1973.

Uloma Dejean, 1821

It is reported a record from Marche, thus confirming the previous indication of the presence of *Uloma culinaris* (Linnaeus, 1758) in that region (Giovagnoli et al., 2012).

II - UPDATING OF THE CHECKLIST OF THE FAUNA OF ITALY

For many years, Tenebrionidae of Italy were grouped only by tribe, according to an ancient tradition that has its best expression especially in the Tables of the monumental book "Fauna coleopterorum italica" by Porta (1934), for over half a century a true "summa" of the Italian systematic entomology, which made it easily accessible, by translating and adapting them, the most classic studies of nearly one hundred years before (between 800 and 900) and, for Tenebrionidae in particular, numerous papers by E. Reitter and H. Gebien. The order of presentation is very similar to that of the more recent check-list by Gardini (1995), which has been widely used and also followed in the preparation of the CD-rom on Coleoptera Tenebrionidae of Italy (Aliquò et al., 2007).

In the 70s and then more frequently from the late 80s of the last century, many studies appeared dealing with systematics of Tenebrionidae (Watt, 1974; Doyen & Lawrence, 1979; Kwieton, 1982; Doyen et al., 1989; Lawrence & Newton, 1995, and subsequently in particular Aalbu et al., 2002; Bouchard et al., 2005; Aalbu, 2006;), in the light of which the overall picture of the Family can be said to have been profoundly changed, with the grouping of tribes in subfamilies according to different schemes which, over time, have been widely accepted.

An authoritative version is given in the recent fundamental catalog of Palaearctic Coleoptera published by Löbl & Smetana (2008), written, of course, with the help of leading specialists in the world. At the same time the opinion that Tenebrionidae comprise the old families Lagriidae and Alleculidae is now accepted by almost everyone. Even the inclusion of the genus *Myrmechixenus* Chevrolat, 1835 (considered, at times, to belong to Mycetophagidae or Colydiidae or to other families) with a 4-4-4 tarsal formula (which is not the Heteromera kind) is not so surprising, because one may find Bolitophagini or Phrenapatinae with a not Heteromera-type tarsal formula. So it's no longer justified not to draw the appropriate conclusions, and a new edition of the CD should be completed including also the species belonging to the subfamily Alleculinae (Fig. 5).

Following the approach adopted by Löbl et al. (2008), the list of Tenebrionidae of Italy and of the species and subspecies definitely present in Italy or reliably indicated by catches in the Italian territory, should be updated as follows.

The updated checklist includes 387 taxa, as some species includes one or more subspecies. All endemic taxa of Italian fauna are 139, species and subspecie, and they are indicated with [E]. When the nominal form of a species is not present in Italy, although substituted by one or more subspecies, it is reported within brackets []. New taxa at the species or subspecies level published after the CD-Rom by Aliquò et al. (2007) are mentioned in bold.

Figure 5. *Isomira melanophtalma*. Corsica, Mausoléo, 16.V.2003, F. Soldati leg.

TENEBRIONIDAE check-list

LAGRIINAE Latreille, 1825

Belopini Reitter, 1917

Centorus Mulsant, 1854
(*Centorus*) *crassipes* (Fischer von Waldheim, 1844)
(*Centorus*) *proceroides* Leo, 1984 **[E]**
[(*Belopus*) *elongatus* (Herbst, 1797)]
ssp. *ecalcaratus* (Seidlitz, 1896)

Cossyphini Latreille, 1802

Cossyphus A.G. Olivier, 1791
(*Cossyphus*) *moniliferus* Chevrolat, 1833
(*Cossyphus*) *tauricus* Steven, 1832

Laenini Seidlitz, 1896

Laena Dejean, 1821
viennensis (Sturm, 1807)

Lagriini Latreille, 1825

Lagria Fabricius, 1775
(*Apteronympha*) *rugosula* Rosenhauer, 1856
= *glabrata* A.G. Olivier, 1797
(*Lagria*) *atripes* Mulsant et Guillebeau, 1855
(*Lagria*) *hirta* (Linnaeus, 1758)

PHRENAPATINAE Solier, 1834

Penetini Lacordaire, 1859

Clamoris Dès Gozis, 1886
crenatus (Mulsant, 1854)

PIMELIINAE Latreille, 1802

Adelostomini Solier, 1834

Machlopsis Pomel, 1871
doderoi Gridelli, 1930

Akidini Billberg, 1820

Akis Herbst, 1799
bacarozzo (Schrank, 1786)
barbara Solier, 1837
italica Solier, 1837
subterranea Solier, 1837
trilineata Herbst, 1799
tuberculata Kraatz, 1865

Asidini Fleming, 1821

Alphasida Escalera, 1905
(*Glabrasida*) *grossa* (Solier, 1836) **[E]**
ssp. *sicula* (Solier, 1836) **[E]**
[(*Glabrasida*) *puncticollis* (Solier, 1836)]
ssp. *moltonii* Canzoneri, 1972 **[E]**
ssp. *tirellii* (Leoni, 1929) **[E]**

Asida Latreille, 1802
(Asida) anachoreta Leo, 2009 **[E]**
(Asida) androgyna Leo, 2012 **[E]**
(*Asida*) *argentierae* Leo, 1980 **[E]**
(*Asida*) *australis* Baudi, 1875 **[E]**
(*Asida*) *bayardi* Solier, 1836 **[E]**
ssp. *blaptoides* Leoni, 1909 **[E]**
ssp. *leosinii* Leoni, 1909 **[E]**
(*Asida*) *calabra* Leoni, 1909 **[E]**
(*Asida*) *combae* Gené, 1839 **[E]**
(*Asida*) *corsica* Laporte de Castelnau, 1833
ssp. *genei* Solier, 1836 **[E]**
(*Asida*) *dejeanii* Solier, 1836
(*Asida*) *doderoi* Leoni, 1910 **[E]**
(*Asida*) *dorgaliensis* Leoni, 1911 [E]
ssp. *montalbica* Reitter, 1917 [E]
(Asida) dryas Leo, 2009 **[E]**
(*Asida*) *fascicularis* (Germar, 1817)
ssp. *fiorii* Leoni, 1909 **[E]**
(*Asida*) *gestroi* Leoni, 1910 **[E]**
ssp. *capraiensis* Gridelli, 1972 **[E]**
ssp. *gardinii* Lo Cascio, 2000 **[E]**
ssp. *lanzai* Leo, 1998 **[E]**
ssp. *tyrrhena* Leoni, 1910 **[E]**
(*Asida*) *glacialis* Gené, 1839 **[E]**
ssp. *barbaricina* Leoni, 1911 **[E]**
ssp. *rustica* Gené, 1839 **[E]**
(*Asida*) *goryi* Solier, 1836 **[E]**
? (*Asida*) *incerta* Leoni, 1910 **[E]**
(*Asida*) *ligurica* Baudi, 1875
(*Asida*) *longicollis* Solier, 1836
(*Asida*) *lostiae* Allard, 1888 **[E]**
(*Asida*) *luigionii* Leoni, 1910 **[E]**

ssp. *doriae* Leoni, 1910 **[E]**
ssp. *insularis* Leoni, 1910 **[E]**
(*Asida*) *lulensis* Reitter, 1917 **[E]**
(*Asida*) *minima* Reitter, 1917 **[E]**
(*Asida*) *novasiriensis* Grimm, 1985 **[E]**
(*Asida*) *nuragica* Leo, 1985 **[E]**
(Asida) nurrae Leo, 2012 **[E]**
(Asida) paulae Leo, 2012 **[E]**
(*Asida*) *piligera* Leoni, 1909 **[E]**
(*Asida*) *pirazzolii* Allard, 1869 **[E]**
ssp. *sardiniensis* Allard, 1869 **[E]**
(*Asida*) *sabulosa* (Fuessly, 1775)
(*Asida*) *sardoa* Leoni, 1910 **[E]**
(Asida) *schusteri* Reitter, 1917
(*Asida*) *solieri* Gené, 1836 **[E]**
ssp. ***caroli*** Leo, 2009 **[E]**
ssp. *fancelloi* Leo, 1985 **[E]**
(*Polasida*) *poneli* F. Soldati et L. Soldati, 2001

Boromorphini Skopin, 1978

Boromorphus Wollaston, 1854
italicus Gardini, 2010 **[E]**

Cnemeplatiini Jacquelin du Val, 1861

Cnemeplatia A. Costa, 1847
atropos A. Costa, 1847

Elenophorini Solier, 1837

Elenophorus Dejean, 1821
collaris (Linnaeus, 1767)

Erodiini Billberg, 1820

Erodius Fabricius, 1775
[(*Erodius*) *audouini* Solier, 1834]
ssp. *destefanii* Failla Tedaldi, 1887 **[E]**
ssp. *peiroleri* Solier, 1834
(*Erodius*) *siculus* Solier, 1834 **[E]**
ssp. *neapolitanus* Solier, 1834 **[E]**
ssp. *dalmatinus* Kraatz, 1865

Pimeliini Latreille, 1802

Pimelia Fabricius, 1775
[(*Pimelia*) *angusticollis* Solier, 1836]
ssp. *punctatorugosa* Reitter, 1915 **[E]**
ssp. *sulcitana* Leo et Pisano, 1978 **[E]**
(*Pimelia*) *bipunctata* Fabricius, 1781
= *papii* Canzoneri, 1963) **[E]**
(*Pimelia*) *cajetana* Sénac, 1887 **[E]**
(*Pimelia*) *goryi* Solier, 1836 **[E]**
ssp. *cassolai* Ardoin, 1973 **[E]**
(*Pimelia*) *grossa* Fabricius, 1792
(*Pimelia*) *payraudi* Latreille, 1829
ssp. *subalpina* Ardoin, 1973 **[E]**
(*Pimelia*) *rugulosa* Germar, 1824 **[E]**
ssp. *apula* Gridelli, 1950 **[E]**
ssp. *sublaevigata* Solier, 1836 **[E]**
(*Pimelia*) *undulata* Solier, 1836 **[E]**

Trachyderma Latreille, 1829
(*Trachyderma*) *lima* (L. Petagna, 1819)

Sepidiini Eschscholtz, 1829

Sepidium Fabricius, 1775
siculum Solier, 1844 **[E]**

Stenosini Lacordaire, 1859

Dichillus Jacquelin du Val, 1861
(*Dichillus*) *corsicus* (Solier, 1838)
= *pumilus* Solier, 1838
(*Dichillus*) minutus (Solier, 1838)
(*Dichillus*) *socius* Rottenberg, 1871 **[E]**
(*Dichillus*) *subtilis* Kraatz, 1862 **[E]**
(Dichillus) tapinomae Leo, 2008 **[E]**
(Dichillus) tyrrhenicus Leo, 2008
(*Dichillocerus*) *pertusus* (Kiesenwetter, 1861)

Eutagenia Reitter, 1886
[*aegyptiaca* Reitter, 1889]
ssp. *tunisea* Normand, 1936
elvirae Marcuzzi et Turchetto, 1982 **[E]**

Microtelus Solier, 1838
lethierryi Reiche, 1860

Stenosis Herbst, 1799
angusticollis (Reiche, 1861)
= *elongatissima* Koch, 1940
brenthoides (Rossi, 1790)
brignonei Koch, 1935 **[E]**
consiglioi Canzoneri, 1976 **[E]**
freyi Koch, 1940
intermedia (Solier, 1838)
melitana Reitter, 1894
sardoa (Küster, 1848)
ssp. *ardoini* Canzoneri, 1970 **[E]**

Tentyriini Eschscholtz, 1831

Imatismus Dejean, 1834
villosus (Haag-Rutenberg, 1870)

Pachychila Eschscholtz, 1831
[(*Pachychila*) *crassicollis* Kraatz, 1865]
ssp. *cossyrensis* (Ragusa, 1875)
(*Pachychila*) *frioli* Solier, 1835
(*Pachychila*) *germari* Solier, 1835
(*Pachychila*) *servillei* (Solier, 1835)
(*Pachychila*) *tazmaltensis* Desbrochers des Loges, 1881
(*Pachychilina*) *dejeani* (Besser, 1832)
ssp. *doderoi* Peyerimhoff, 1927

Tentyria Latreille, 1802
(*Tentyria*) *grossa* Besser, 1832
ssp. *angustata* Kraatz, 1896 **[E]**
ssp. *sommieri* Baudi, 1874 **[E]**
ssp. *sardiniensis* Ardoin, 1973**[E]**
(*Tentyria*) *italica* Solier, 1835
(*Tentyria*) *laevigata* Steven, 1829 **[E]**
(*Tentyria*) *rugosa* Gené, 1836 **[E]**
ssp. *cassolai* Ardoin, 1973 **[E]**
ssp. *floresii* Gené, 1836 **[E]**
(*Subtentyrina*) *ligurica* Solier, 1835
ssp. *confusa* Ardoin, 1973 **[E]**
ssp. *pseudorugosa* Ardoin, 1973 **[E]**
(*Subtentyrina*) *ramburi* Solier, 1835
= *maillei* Solier, 1835

Zophosini Solier, 1834

Zophosis Latreille, 1802
(*Oculosis*) *punctata* Brullé, 1832

TENEBRIONINAE Latreille, 1802

Alphitobiini Reitter, 1917

Alphitobius Stephens, 1829
diaperinus (Panzer, 1796)
laevigatus (Fabricius, 1781)

Diaclina Jacquelin du Val, 1861
fagi (Panzer, 1799)
testudinea (Piller et Mitterpacher, 1783)

Blaptini Leach, 1815

Blaps Fabricius, 1775
(*Blaps*) *gibba* Laporte de Castelnau, 1840
(*Blaps*) *gigas* (Linnaeus, 1767)
(*Blaps*) *lethifera* Marsham, 1802
(*Blaps*) *mucronata* Latreille, 1804
[(*Blaps*) *nitens* Laporte de Castelnau, 1840]
ssp. *mercatii* Canzoneri, 1969 **[E]**

Bolitophagini Kirby, 1837

Bolitophagus Illiger, 1798
interruptus Illiger, 1800
reticulatus (Linnaeus, 1767)

Eledona Latreille, 1796
agricola (Herbst, 1783)

Eledonoprius Reitter, 1911
armatus (Panzer, 1799)
serrifrons Reitter, 1890

Helopini Latreille, 1802

Accanthopus Dejean, 1821
= *Enoplopus* Solier, 1848
velikensis (Piller et Mitterpacher, 1783)
= *dentipes* (Rossi, 1790)

Allardius Ragusa, 1898
oculatus (Baudi di Selve, 1876) **[E]**
sardiniensis (Allard, 1877) **[E]**

Catomus Allard, 1876
(*Catomus*) *consentaneus* (Küster, 1851)
(*Catomus*) *rotundicollis* (Guérin-Méneville, 1825)

Gunarus Dès Gozis, 1886
parvulus (Lucas, 1846)

Helops Fabricius, 1775
(*Helops*) *caeruleus* (Linnaeus, 1758)
(*Helops*) *rossii* Germar, 1817

Italohelops Español, 1961
subchalybaeus (Reitter, 1907) [E]

Nalassus Mulsant, 1854
(*Nalassus*) *aemulus* (Küster, 1850)

ssp. *calaritanus* Leo, 1985 **[E]**
(*Nalassus*) *alpigradus* (Fairmaire, 1883)
(*Nalassus*) *convexus* (Comolli, 1837)
(*Nalassus*) *dermestoides* (Illiger, 1798)
(*Nalassus*) *dryadophilus* (Mulsant, 1854)
(*Nalassus*) *ecoffeti* (Küster, 1850)
= *picinus* (Küster, 1850)
(*Nalassus*) *genei* (Gené, 1839)
ssp. *melonii* Leo, 1982 [E]
(*Nalassus*) *pastai* Aliquò, Leo et Lo Cascio, 2006 **[E]**
(*Nalassus*) *planipennis* (Küster, 1850) **[E]**
(*Nalassus*) *plebejus* (Küster, 1850)
(*Helopondrus*) *assimilis* (Küster, 1850)

Nephodinus Gebien, 1943
= *Nephodes* Blanchard, 1845
(*Nephodinus*) *metallescens* (Küster, 1846)

Odocnemis Allard, 1876
(*Odocnemis*) *clypeatus* (Küster, 1851) **[E]**
(*Odocnemis*) *exaratus* (Germar, 1817)
(*Odocnemis*) *osellai* (Gardini, 1979) **[E]**
(*Odocnemis*) *ruffoi* (Canzoneri, 1970) **[E]**

Probaticus Seidlitz, 1896
(*Helopotrichus*) *gibbithorax* (Gemminger, 1870) **[E]**
(*Helopotrichus*) *sphaericollis* (Küster, 1850) **[E]**
(*Helopotrichus*) *tomentosus* (Reitter, 1906)
= *siculus* (Canzoneri, 1960) **[E]**
(*Pelorinus*) *anthrax* (Seidlitz, 1896) **[E]**
(Pelorinus) cossyrensis Sparacio, 2007 **[E]**
(*Pelorinus*) *ebeninus* (A. Villa et J.B. Villa, 1838)
ssp. *cassolai* Ardoin, 1973 **[E]**

Raiboscelis Allard, 1876
azureus (Brullé, 1832)

Stenohelops Reitter, 1922
(*Gunarellus*) *carlofortinus* Leo, 1980 **[E]**

Stenomax Allard, 1876
(*Stenomax*) *aeneus* (Scopoli, 1763)
(*Asyrmatus*) *foudrasii* (Mulsant, 1854)
(*Asyrmatus*) *piceus* (J. Sturm, 1826)

Xanthomus Mulsant, 1854
pallidus (Curtis, 1830)
= *ghidinii* Canzoneri, 1959; *residuus* Canzoneri, 1959

pellucidus (Mulsant et Rey, 1856)
grimmi Ferrer et Whitehead, 2002 **[E]**

Melanimini Seidlitz, 1894

Cheirodes Gené, 1839
(*Cheirodes*) *sardous* Gené, 1839
(*Pseudanemia*) *brevicollis* Wollaston, 1864

Melanimon Steven, 1829
tibiale (Fabricius, 1781)

Opatrini Brullé, 1832

Ammobius Guerin-Méneville, 1844
rufus (Lucas, 1846)

Clitobius Mulsant et Rey, 1859
(*Clitobius*) *ovatus* (Erichson, 1843)

Dilamus Jacquelin du Val, 1861
(*Dilamus*) *planicollis* Fairmaire, 1883

Gonocephalum Solier, 1834
(*Gonocephalum*) *assimile* (Küster, 1849) **[E]**
(*Gonocephalum*) *costatum* (Brullé, 1832)
[(*Gonocephalum*) *granulatum* (Fabricius, 1792)]
ssp. *meridionale* (Küster, 1849)
ssp. *nigrum* (Küster, 1849)
(*Gonocephalum*) *lefranci* (Fairmaire, 1863)
(*Gonocephalum*) *obscurum* (Küster, 1849)
(*Gonocephalum*) *perlexum* (Lucas, 1846)
(*Gonocephalum*) *pygmaeum* (Steven, 1829)
(*Gonocephalum*) *rusticum* (A.G. Olivier, 1811)
(*Gonocephalum*) *setulosum* (Faldermann, 1837)

Opatroides Brullé, 1832
punctulatus Brullé, 1832

Opatrum Fabricius, 1775
(*Opatrum*) *asperidorsum* Fairmaire, 1878
(*Opatrum*) *dahli* Küster, 1849 **[E]**
(*Opatrum*) *italicum* Reitter, 1904 **[E]**
(*Opatrum*) *obesum* A.G. Olivier, 1811
(*Opatrum*) *sabulosum* (Linnaeus, 1760)
ssp. *lucifugum* Küster, 1849
ssp. *sculptum* Rey, 1892
(*Opatrum*) *sculpturatum* Fairmaire, 1860
ssp. *capraiense* Razzauti, 1919 **[E]**
ssp. *igiliense* Razzauti, 1919 **[E]**

ssp. *ilvense* Razzauti, 1919 **[E]**
ssp. *urgonense* Razzauti, 1919 **[E]**
(*Opatrum*) *verrucosum* Germar, 1817
(*Colpophorus*) *emarginatum* Lucas, 1846
(*Colpophorus*) *nivale* (Gené, 1839) **[E]**
(*Colpophorus*) *validum* Rottenberg, 1871 **[E]**
ssp. *marcuzzii* Canzoneri, 1972 **[E]**
ssp. *rottenbergi* Canzoneri, 1972 **[E]**
ssp. *schlicki* Gebien, 1906

Sclerum Dejean, 1834
armatum (Waltl, 1835)
multistriatum (Forskål, 1775)

Sinorus Mulsant et Reveillière, 1860
colliardi (Fairmaire, 1860)

Palorini Matthews, 2003

Palorus Mulsant, 1854
depressus (Fabricius, 1790)
ratzeburgii (Wissmann, 1848)
subdepressus (Wollaston, 1864)

Ulomina Baudi, 1876
carinata Baudi, 1876

Pedinini Eschscholtz, 1829

Allophylax Bedel, 1906
(*Allophylax*) *brevicollis* (Baudi, 1876) **[E]**
(*Allophylax*) *picipes* (A.G. Olivier, 1811)
(*Allophylax*) *sardous* (Baudi, 1876) **[E]**
(*Phylaximon*) *costatipennis* (Lucas, 1846)
ssp. *godenigoi* Canzoneri, 1970 **[E]**

Bioplanes Mulsant, 1854
meridionalis Mulsant, 1854

Colpotus Mulsant et Rey, 1853
godarti Mulsant et Rey, 1853
strigosus (A. Costa, 1847) **[E]**
ssp. *ganglbaueri* D'Amore Fracassi, 1907 **[E]**
ssp. *oglasensis* Gardini, 1975 **[E]**
ssp. *ragusai* D'Amore Fracassi,1907 **[E]**

Dendarus Dejean, 1821
(*Dendarus*) *carinatus* (Mulsant et Rey, 1854)
(*Dendarus*) *coarcticollis* (Mulsant, 1854)
= *tristis* sensu Laporte de Castelnau, 1840
(*Paroderus*) *lugens* (Mulsant et Rey, 1854)
(*Pandarinus*) *dalmatinus* (Germar, 1824)
(Pandarinus) peslieri Soldati, 2012

Heliopathes Dejean, 1834
(*Heliopates*) *avarus* Mulsant et Rey, 1854
ssp. *donatellae* (Canzoneri, 1970) **[E]**
(*Heliopates*) *neptunius* Baudi, 1875 **[E]**

Leichenum Dejean, 1834
pictum (Fabricius, 1801)
pulchellum (Lucas, 1846)

Pedinus Latreille, 1796
(*Pedinus*) *fallax* Mulsant et Rey, 1853
(*Pedinus*) *femoralis* (Linnaeus, 1767)
(*Pedinus*) *helopioides* Germar, 1814
(*Pedinus*) *longulus* Rottenberg, 1871 **[E]**
(*Pedinus*) *meridianus* Mulsant et Rey, 1853
(*Pedinus*) *punctatostriatus* Mulsant et Rey, 1853 **[E]**
(*Pedinus*) *sicanus* Canzoneri, 1984 **[E]**
(*Pedinus*) *siculus* Seidlitz, 1893 **[E]**
(*Pedinulus*) *ragusae* Baudi, 1876
= *jonicus* Kiesenwetter, 1880

Phylan Dejean, 1821
[(*Phylan*) *abbreviatus* (A.G. Olivier, 1795)]
ssp. *italicus* (Reitter, 1904) **[E]**
(Phylan) poggii Ferrer, 2013 **[E]**

Psammoardoinellus Leo, 1980
sardiniensis (Ardoin, 1972) **[E]**

Scaurini Billberg, 1820

Scaurus Fabricius, 1775
aegyptiacus Solier,1838
= *giganteus* Küster, 1848
atratus Fabricius, 1775
striatus Fabricius, 1792
tristis A.G. Olivier, 1795
uncinus (Forster, 1771)
= *punctatus* Fabricius, 1798)

Tenebrionini Latreille, 1802

Neatus J.L. Le Conte, 1862
noctivagus (Mulsant et Rey, 1853)
picipes (Herbst, 1797)

Tenebrio Linnaeus, 1758
(*Tenebrio*) *molitor* Linnaeus, 1758
(*Tenebrio*) *obscurus* Fabricius, 1792
(*Tenebrio*) *opacus* Duftschmid, 1812
(*Tenebrio*) *punctipennis* Seidlitz, 1896

Triboliini Gistel, 1848

Latheticus Waterhouse, 1880
oryzae Waterhouse, 1880

Lyphia Mulsant et Rey, 1859
tetraphylla (Fairmaire, 1856)

Tribolium W. S. Mac Leay, 1825
castaneum (Herbst, 1797)
confusum Jacquelin du Val, 1861
madens (Charpentier, 1825)

Ulomini Dejean, 1821

Uloma Dejean, 1821
culinaris (Linnaeus, 1758)
rufa (Piller et Mitterpacher, 1783)

DIAPERINAE Latreille, 1802

Crypticini Brullé, 1832

Crypticus Latreille, 1817
(*Crypticus*) *gibbulus* (Quensel, 1806)
(*Crypticus*) *quisquilius* (Linnaeus, 1760)
ssp. *aprutianus* Gridelli, 1949 **[E]**

Lamprocrypticus Español, 1950
alpinus (Comolli, 1837)

Oochrotus Lucas, 1852
unicolor Lucas, 1852
ssp. *ardoini* Canzoneri, 1961 **[E]**
ssp. *moltonii* Canzoneri, 1961 **[E]**

Pseudoseriscius Español, 1950
griseovestis (Fairmaire, 1879)
helvolus (Küster, 1852)
ssp. *adriaticus* (Español, 1949)
[*normandi* (Español, 1949)]
ssp. *pacificii* Leo, 1982 **[E]**
[*olivierii* (Desbrochers des Loges, 1881)]
ssp. *sardiniensis* Leo, 1982 **[E]**

Diaperini Latreille, 1802

Alphitophagus Stephens, 1832
bifasciatus (Say, 1824)

Diaperis Geoffroy, 1762
boleti (Linnaeus, 1758)

Gnatocerus Thunberg, 1814
(*Gnatocerus*) *cornutus* (Fabricius, 1798)
(*Echocerus*) *maxillosus* (Fabricius, 1801)

Neomida Latreille, 1829
haemorroidalis (Fabricius, 1787)

Pentaphyllus Dejean, 1821
chrysomeloides (Rossi, 1792)
testaceus (Hellwig, 1792)

Platydema Laporte de Castelnau et Brullé, 1831
europaea Laporte de Castelnau et Brullé, 1831
violacea (Fabricius, 1790)

Hypophlaeini Billberg, 1820

Corticeus Piller et Mitterpacher, 1783
(*Corticeus*) *bicolor* (A.G. Olivier, 1790)
(*Corticeus*) *bicoloroides* (Roubal, 1933)
(*Corticeus*) *fasciatus* (Fabricius, 1790)
(*Corticeus*) *fraxini* (Kugelann, 1794)
(*Corticeus*) *linearis* (Fabricius, 1790)
(*Corticeus*) *pini* (Panzer, 1799)
= *leonhardi* (Reitter, 1906)
(*Corticeus*) *suberis* (Lucas, 1846)
(*Corticeus*) *unicolor* Piller et Mitterpacher, 1783
(*Corticeus*) *versipellis* (Baudi, 1876)

Myrmechixenini Jacquelin du Val, 1858

Myrmechixenus Chevrolat, 1835
picinus (Aubé, 1850)
subterraneus Chevrolat, 1835
vaporariorum Guérin-Méneville, 1843

Phaleriini Blanchard, 1845

Halammobia Semenov, 1901
pellucida (Herbst, 1799)

Phaleria Latreille, 1802
(*Phaleria*) *acuminata* Küster, 1852
(*Phaleria*) *bimaculata* (Linnaeus, 1767)
= *marcuzzii* Aliquò, 1993
ssp. *adriatica* Rey, 1891
(*Phaleria*) *insulana* Rey, 1890
[(*Phaleria*) *provincialis* Fauvel, 1901]
ssp. *ghidinii* Canzoneri, 1961 [E]
ssp. *intermedia* Schuster, 1930
(*Phaleria*) *reveillierei* Mulsant et Rey, 1858

Phtora Germar, 1836
(*Phtora*) *crenata* (Germar, 1836)

Scaphidemini Reitter, 1922

Scaphidema L. Redtenbacher, 1849
metallica (Fabricius, 1792)

Trachyscelini Blanchard, 1845

Trachyscelis Latreille, 1809
aphodioides Latreille, 1809

ALLECULINAE Laporte de Castelnau, 1840

Alleculini Laporte de Castelnau, 1840

Allecula Fabricius, 1801
(*Allecula*) *morio* (Fabricius, 1787)
(*Allecula*) *rhenana* Bach, 1856
(*Upinella*) *aterrima* (Rosenhauer, 1847)

Hymenalia Mulsant, 1856
rufipes (Fabricius, 1792)

Hymenophorus Mulsant, 1851
doublieri Mulsant, 1851

Prionychus Solier, 1835
ater (Fabricius, 1775)
fairmairei (Reiche, 1860)
lugens (Küster, 1850)
melanarius (Germar, 1813)

Gerandryus Rottenberg, 1873
aetnensis (Rottenberg, 1871)

Gonodera Mulsant, 1856
luperus (Herbst, 1783)
metallica (Küster, 1850)

Isomira Mulsant, 1856
(*Isomira*) *anaspiformis* Weise, 1974 **[E]**
(*Isomira*) *genistae* (Rottenberg, 1871) **[E]**
(*Isomira*) *hypocrita* Mulsant, 1856
(*Isomira*) *icteropa* (Küster, 1852)
(*Isomira*) *marcida* Kiesenwetter, 1863
(*Isomira*) *melanophthalma* (Lucas, 1846)
= *ferruginea* (Küster, 1850)
(*Isomira*) *murina* (Linnaeus, 1758)
= *semiflava* (Küster, 1852)
(*Isomira*) *ochropus* (Küster, 1850)
= *parvula* (Rottenberg, 1870)
(*Isomira*) *parvuloides* Weise, 1974 **[E]**
(*Isomira*) *testacea* Seidlitz, 1896
= *paupercula* (Baudi, 1883)
(*Isomira*) *umbellatarum* (Kiesenwetter, 1863)
(*Danielomira*) *scutellaris* (Baudi, 1877) **[E]**
(*Heteromira*) *costessii* (Bertolini, 1868)
(*Heteromira*) *moroi* Hölzel, 1958

Pseudocistela Crotch, 1873
ceramboides (Linnaeus, 1758)

Mycetochara Berthold, 1827
(*Mycetochara*) *axillaris* (Paykull, 1799)
(*Mycetochara*) *flavipes* (Fabricius, 1792)
(*Ernocharis*) *flavipennis* Reitter, 1908 **[E]**
(*Ernocharis*) *humeralis* (Fabricius, 1787)
(*Ernocharis*) *maura* (Fabricius, 1792)
= *linearis* (Illiger, 1794)
(*Ernocharis*) *pygmaea* (L. Redtenbacher, 1874)
(*Ernocharis*) *quadrimaculata* (Latreille, 1804)
(*Ernocharis*) *thoracica* (Gredler, 1854)

Cteniopodini Solier, 1835

Cteniopus Solier, 1835
(*Cteniopus*) *neapolitanus* Baudi, 1877 **[E]**
(*Cteniopus*) *sulphureus* (Linnaeus, 1758)
(*Rhinobarus*) *sulphuripes* (Germar, 1824)

Heliotaurus Mulsant, 1856
(*Heliotaurus*) *distinctus* (Laporte de Castelnau, 1840)

Megischia Solier, 1835
curvipes (Brullé, 1832)

Megischina Reitter, 1906
armillata (Brullé, 1832)

Omophlus Dejean, 1834
(*Euomophlus*) *rugosicollis* (Brullé, 1832)
(*Odontomophlus*) *dispar* A. Costa, 1847 **[E]**
(*Odontomophlus*) *fallaciosus* Rottenberg, 1871 **[E]**
(*Odontomophlus*) *flavipennis* Küster, 1849
(*Odontomophlus*) *infirmus* Kirsch, 1869
(*Odontomophlus*) *lepturoides* (Fabricius, 1787)
(*Omophlus*) *longicornis* Bertolini, 1868
(*Omophlus*) *proteus* Kirsch, 1869
(*Paromophlus*) *hirtus* Seidlitz, 1896
(*Paromophlus*) *lividipes* Mulsant, 1856
(*Paromophlus*) *picipes* (Fabricius, 1792)
(*Paromophlus*) *pubescens* (Linnaeus, 1758)
= *betulae* (Herbst, 1783), *rufitarsis* (Leske, 1785)

Podonta Solier, 1835
italica Baudi, 1877 **[E]**
nigrita (Fabricius, 1794)

STENOCHIINAE Kirby, 1837

Cnodalonini Gistel, 1856

Iphthiminus Spilman, 1973
italicus (Truqui, 1857)
Menephilus Mulsant, 1854
cylindricus (Herbst, 1784)

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REFERENCES

Aalbu R.A., 2006. 2006, where are we at: assessing the currents state of Tenebrionidae systematic on a global scale (Coleoptera: Tenebrionidae). Cahiers scientifiques, Département du Rhône, Muséum Lyon, 10: 55–70.

Aalbu R.A., Triplehorn C.A., Campbell J.M., Brown K.W., Somerby R.E. & Thomas D.B., 2002. Family 106. Tenebrionidae, The Darkling Beetles. In: Arnett R.H. Jr, Thomas M.C., Skelley P.E. & Frank J.H. (Eds.). American Beetles. Vol. 2: Polyphaga, Scarabaeoidea through Curculionoidea. CRC Press, Boca Raton-London-New York-Washington, pp. 463-509.

Aliquò V., Rastelli M., Rastelli S. & Soldati F., 2007. Coleotteri Tenebrionidi d'Italia - Darkling Beetles of Italy. Piccole Faune II. CD-Rom. Museo Civico di Storia Naturale di Carmagnola (Torino), Associazione Naturalistica Piemontese (Torino), Progetto Biodiversità, Comitato Parchi (Roma).

Bouchard P., Lawrence J.F., Davies A.E. & Newton A.F., 2005. Synoptic classification of the World Tenebrionidae (Insecta: Coleoptera) with a review of family-group names. Annales Zoologici, 55: 499–530.

Doyen J.T. & Lawrence J.F., 1979. Relationships and higher classification of some Tenebrionidae and Zopheridae (Coleoptera). Systematic Entomology, 4: 333–377.

Doyen J.T., Matthews E.G. & Lawrence J.F., 1989. Classification and Annotated Checklist of the Australian Genera of Tenebrionidae (Coleoptera). Invertebrate Taxonomy, 3: 229–260.

Evangelista M., 2011. Segnalazioni faunistiche italiane, 521–522: *Latheticus oryzae* Waterhouse, 1880 e *Pentaphyllus testaceus* (Hellwig, 1792) (Coleoptera Tenebrionidae). Bolletino della Società Entomologica Italiana, 143: 139.

Ferrer J., Martínez Fernández J.C. & Castro Tovar A., 2008. Aportación al conocimiento del género *Akis* Herbst, 1799 (Coleoptera, Tenebrionidae, Pimeliinae). Boletín de la Sociedad Entomológica Aragonesa, 43: 153–172.

Ferrer J. & Castro Tovar A., 2012. Contribución al estudio del género *Pimelia* F. *Pimelia muricata* Olivier, 1795, una especie válida de la fauna francesa (Coleoptera, Tenebrionidae, Pimeliinae). Nouvelle Revue d'Entomologie, 28: 83–91.

Ferrer J., 2013. Sobre la identidad y distribución geográfica de *Phylan gibbus* (Fabricius, 1775) y sus presuntas sinonimias (Coleoptera, Tenebrionidae, Pedinini). Boletín de la Sociedad Entomológica Aragonesa, 52: 49–65.

Gardini G., 1995. Coleoptera Lagriidae, Alleculidae, Tenebrionidae. In: Minelli A., La Posta S. & Ruffo S. (Eds.). Check-list delle specie della fauna d'Italia. Vol. 58. Calderini, Bologna, 17 pp.

Gardini G., 2010. *Boromorphus italicus* n. sp. dell'Italia meridionale (Coleoptera, Tenebrionidae). Doriana, Supplemento agli Annali del Museo Civico di Storia Naturale G. Doria", 8 (368): 1–12.

Giovagnoli G., Strocchi A. & Paglialunga M., 2012. Coleotteri della Regione Marche. Primo contributo alla conoscenza della coleotterofauna della Regione Marche (Insecta Coleoptera Carabidae, Buprestidae, Meloidae, Tenebrionidae, Lucanidae, Bolboceratidae, Melolonthidae, Cetoniidae, Cerambycidae). Quaderni per gli Studi Naturalistici della Romagna, 36 : 159–184.

International Commission on Zoological Nomenclature (ICZN), 1999. International Code of Zoological Nomenclature, Fourth Edition. ICZN, London, 306 pp.

Kwieton E., 1982. Revue critique des systèmes récents de la famille des Tenebrionidae (Col.). Sborník Národního Muzea V Praze, 38 B: 79–100.

Lawrence J.F. & Newton A.F., 1995. Families and subfamilies of Coleoptera, with selected genera, notes, references and data on family-group names. In: Pakaluk J. & Slipinski S.A. (Eds.). Biology, Phylogeny and Classification of Coleoptera. Papers celebrating the 80th birthday of Roy A. Crowson. Museum i Instytut Zoologii PAN, Warszawa, pp. 779–1006.

Leo P., 2008. Osservazioni su *Dichillus corsicus* e descrizione di tre nuove specie del Mediterraneo occidentale (Coleoptera, Tenebrionidae). Annali del Museo Civico di Storia Naturale « G. Doria », 99: 603–627.

Leo P., 2009. Observations on some Tenebrionidae (Coleoptera) from Sardinia, with description of three new *Asida*. In: Cerretti P., Mason F., Minelli A., Nardi G. & Whitmore D. (Eds.). Research on the Terrestrial Arthropods of Sardinia (Italy). Zootaxa, 2318: 400–420.

Leo P., 2012. Tre nuove specie di *Asida* della Sardegna (Coleoptera, Tenebrionidae). Annali del Museo Civico di Storia Naturale « G. Doria », 104: 97–113.

Leo P., Soldati F. & Soldati L., 2011. A new species of the genus *Opatrum* Fabricius, 1775 from South-Eastern Corsica (Insecta: Coleoptera: Tenebrionidae). Annales Zoologici, 61: 277–280.

Löbl I., Ando K., Bouchard P., Egorov L.V., Iwan D., Lillig M., Masumoto K., Merkl O., Nabozhenko M., Novak V., Pettersson R., Schawaller W. & Soldati F., 2008. Family Tenebrionidae. In: Löbl I. & Smetana A. (Eds.). Catalogue of Palaearctic Coleoptera, vol. 5, Tenebrionoidea. Apollo Books, Stenstrup, 670 pp.

Löbl I. & Smetana A. (Eds.), 2008. Catalogue of Palaearctic Coleoptera, vol. 5, Tenebrionoidea. Apollo Books, Stenstrup, pp. 30–45, 105-352 and 467–645.

Lo Cascio P. & Pasta S., 2012. Lampione, a paradigmatic case of Mediterranean Island biodiversity. Biodiversity Journal, 3: 311–330.

Porta A., 1934. Fauna Coleopterorum Italica, vol. IV: Heteromera-Phytophaga. Stabilimento Tipografico Piacentino, Piacenza, 415 pp.

Silfverberg H., 1984. The Coleopteran genera of Dejean, 1821. II. Polyphaga. 1. Annales Entomologici Fennici, 50: 58–60.

Sparacio I., 2007. Nuovi coleotteri di Sicilia (Coleoptera Carabidae e Tenebrionidae). Il Naturalista siciliano, 31: 249–259.

Soldati F., 2012. A new species of the genus *Dendarus* Dejean 1821 from Greece (Coleoptera, Tenebrionidae). Revue de l'Association Roussillonnaise d' Entomologie, 21: 52–59.

Watt J.C., 1974. A revised subfamily classification of Tenebrionidae (Coleoptera). New Zealand Journal of Zoology, 1: 381–452.